WORKING GROUP ON ELASMOBRANCH FISHES (WGEF)

Please note: Annex 4 was added to this report in January 2022.

VOLUME 3 | ISSUE 59

ICES SCIENTIFIC REPORTS

RAPPORTS SCIENTIFIQUES DU CIEM

ICES INTERNATIONAL COUNCIL FOR THE EXPLORATION OF THE SEA

CIEM CONSEIL INTERNATIONAL POUR L'EXPLORATION DE LA MER

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ISSN number: 2618-1371

ICES Scientific Reports

Volume 3 | Issue 59

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Recommended format for purpose of citation:

ICES. 2021. Working Group on Elasmobranch Fishes (WGEF).
ICES Scientific Reports. 3:59. 822 pp. https://doi.org/10.17895/ices.pub.8199

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Contents

i Executive summary

ICES WGEF meets annually and is responsible for providing assessments and advice on the state of the stocks of sharks, skates, and rays throughout the ICES area. In 2021, WGEF provided advice for 16 stocks of rays and skates distributed the North Sea ecoregion, the Azores and MAR; catsharks (Scyliorhinidae) in the Greater North Sea, Celtic Seas and Bay of Biscay and Iberian Coast ecoregions; smooth-hounds in the Northeast Atlantic; and tope shark in the Northeast Atlantic.

Despite improvements of reported landings in the past decade, quality check and error corrections, reliable time-series of landings do not span more than 10–12 years for most stocks. Estimated discards are uncertain because elasmobranchs are mostly bycatch in all types of fisheries and national sampling effort might be insufficient for estimating precise and unbiased discards for elasmobranchs. Further, survival of discarded elasmobranchs is thought to be high but quantitative estimates are scarce so that the relationship between discards and dead catches is unknown. As a consequence, for numerous stocks it is not possible to provide catch advice. For those stocks, advice on landings is formulated.

The majority of WGEF stocks are assessed as Category 3 stocks, i.e. the advice is based on trends derived from scientific surveys. In November 2020, a workshop (WKSKATE) was held to evaluate criteria for the representativeness of surveys as well as to standardize and revise methods for calculating stock size indicators. Recommendations from WKSKATE were reviewed by the group and applied to the assessments where deemed appropriate. Consequently, for three stocks i.e. thornback ray and lesser spotted dogfish in the greater North Sea (rjc.27.3a47d and syc.27.3a47d) and smooth-hound in the ICES area (sdv.27.nea) surveys were added to the assessment, while for spotted ray in the North Sea (rjm.27.3a47d) the UK(E&W)–BTS–Q3 was excluded. For those stocks classified as ICES category 5 and 6 stocks, i.e. for which even survey data are lacking and only (minor) landings or some bycatch data are available, potential surveys were evaluated.

No assessment was done for three (tope, gag.27.nea, Rajidae in the greater North Sea, raj.27.3a47d, and blonde ray in Subarea 6 and Division 4a, rjh.27.4a6) out of 16 stocks. For these stocks, advices are only based on landings or catches according to the ICES precautionary approach. In addition, for the three stocks in the Bay of Biscay and Iberian coast ecoregion (two stocks of lesser spotted dogfish, syc.27.8c9a and syc.27.8abd, and one stock of blackmouth dogfish, sho.27.89a) no advice was requested. In the North Sea, among the five stocks for which the trend in biomass could be estimated, this trend was increasing for two stocks (rjc.27.3a47d and spotted ray in divisions 4.c and 7.d, rjh.27.4c7d), decreasing for two (rjm.27.3a47d and cuckoo ray, rjn.27.3a4) and stable for one (lesser spotted dogfish, syc.27.3a47d). In the Celtic Sea, among the three stocks for which the trend in biomass could be estimated, this trend was slightly increasing for two stocks of dogfishes (syc.27.67a-ce-j and syt.27.67) and decreasing for the third one (sho.27.67). Furthermore, for smooth-hound (*Mustelus spp.*) in the ICES area (sdv.27.nea) an increasing trend in biomass was observed.

COVID-19 or legal and technical issues caused several surveys not or only partially completed in 2020. For surveys missing 2020 data, the 2 over 5 index ratio was calculated by treating the 2020 value as missing, i.e. the last 2-year average is based on a single value of 2019. If only a part of the 2020 data was missing (e.g. FR-CGFS-Q4) the effect of the lack of survey stations on the biomass indicators was estimated. For stocks where the impact or the missing strata was large or could not be assessed the 2020, data were excluded from the biomass index.

In March 2022, a benchmark for porbeagle, thornback ray in the Bay of Biscay, cuckoo ray in subareas 6 and 7, and in divisions 8.a–b and 8.d and undulate ray in the English Channel is organised (WKELASMO). Furthermore, a benchmark for three North Sea stocks is proposed for 2023. It will be the first time these stocks will go through a benchmark. In addition, a second WKSKATE workshop that would examine the remaining skate and ray stocks is being planned.

ii Expert group information

Expert group name	Working Group on Elasmobranch Fishes (WGEF)
Expert group cycle	Annual
Year cycle started	2021
Reporting year in cycle	1/1
Chairs	Jurgen Batsleer, The Netherlands
	Pascal Lorance, France
Meeting venue and dates	15-24 June 2021, Online meeting, 30 participants

1 Introduction

1.1 Terms of Reference

2020/2/FRSG13 The Working Group Elasmobranch Fishes (WGEF), chaired by Jurgen Batsleer (Netherlands) and Pascal Lorance (France), will meet online from 15–24 June 2021 to:

a) Address generic ToRs for Regional and Species Working Groups.
b) Update the description of elasmobranch fisheries for deep-water, pelagic and demersal species in the ICES area and compile landings, effort and discard statistics by ICES Subarea and Division, and catch data by NEAFC Regulatory Area. Describe and prepare a first Advice draft of any emerging elasmobranch fishery with the available data on catch/landings, fishing effort and discard statistics at the finest spatial resolution possible in the NEAFC RA and ICES area(s);
c) Evaluate the stock status for the provision of biennial advice due in 2021 for: (i) skate stocks in the North Sea ecoregion, the Azores and MAR; (ii) catsharks (*Scyliorhinidae*) in the Greater North Sea, Celtic Seas and Bay of Biscay and Iberian Coast ecoregions; (iii) smooth-hounds in the Northeast Atlantic; and (iv) tope in the Northeast Atlantic
d) Conduct exploratory analyses and collate relevant data in preparation for the evaluation of other stocks (Porbeagle in the NE Atlantic; and skates in the Celtic Seas and Bay of Biscay and Iberian Coast ecoregions) in preparation for more detailed biennial assessment in 2022;
e) Follow the outcomes of WKSKATE and to make the best use of survey indices in the assessments where appropriate.
f) Take note of the outcome of the proposed stand-alone expert meeting dealing with the issue of missing data in the Portuguese surveys and the solutions suggested.
g) Collate discard data from countries and fleets according to the ICES data call. Follow recommendations from WKSHARK3 and 5 to address the following issues: data quality and onboard coverage; raising factors; discard retention patterns between fleets and countries; and consider the output of WKSURVIVE to address discard survival and advise on how to include discard information in the assessment and advice accordinly;
h) Carry out exploration analysis of effort data for stocks where time-series of effort may be used to decide on the application of the PA buffer. The use of effort data analysed in other ICES working groups should be favored, liaise with WGMIXFISH and WGSFD.
i) Further develop MSY proxy reference points relevant for elasmobranchs and explore/apply in MSY Proxies analyses for selected stocks;
j) Further develop the ToR for a proposed joint ICCAT-ICES meeting on porbeagle and other pelagic sharks.
k) Work intersessionally to draft/update stock annexes and then develop a procedure an schedule for subsequent reviews
l) Evaluate available data at species-specific level within the common skate-complex (*Dipturus* spp.) stock units in order to further increase our understanding of each individual species and their current status.”

The assessments will be carried out on the basis of the stock annex in National Laboratories, prior to the meeting.

The assessments must be available for audit on the first day of the meeting.

Material and data relevant for the meeting must be available to the group no later than 14 days prior to the starting date.

WGEF will report by 9 August 2021 for the attention of ACOM.

Only experts appointed by national Delegates or appointed in consultation with the national delegates of the expert's country can attend this Expert Group

1.2 Background and history

The Study Group on Elasmobranch Fishes (SGEF), having been first established in 1989 (ICES, 1989), was re-established in 1995 and had meetings or met by correspondence in subsequent years (ICES, 1995–2001). Assessments for elasmobranch species had been hampered by a lack of data. The 1999 meeting was held concurrently with an EC-funded Concerted Action Project meeting (FAIR CT98-4156) allowing greater participation from various European institutes. Exploratory assessments were carried out for the first time at the 2002 SGEF meeting (ICES, 2002), covering eight of the nine case-study species considered by the EC-funded DELASS project (CT99-055). The success of this meeting was due largely to the DELASS project, a three-year collaborative effort involving 15 fisheries research institutes and two subcontractors (Heessen, 2003). Though much progress was made on methods, there was still much work to be done, with the paucity of species-specific landings data a major data issue.

In 2002, SGEF recommended the group be continued as a working group. The medium-term remit of this group being to extend the methods and assessments for elasmobranchs prepared by the EC-funded DELASS project; to review and define data requirements (fishery, survey and biological parameters) for stock identification, analytical models and to carry out such assessments as are required by ICES customers.

In 2003, WGEF met in Vigo, Spain and worked to further the stock assessment work carried out under DELASS. In 2003, landings data were collated for the first time. This exercise was based on data from ICES landings data, the FAO FISHSTAT database, and data from national scientists (ICES, 2003). In 2004, WGEF worked by correspondence to collate and refine catch statistics for all elasmobranchs in the ICES area. This task was complicated by the use (by many countries) of generic reporting categories for sharks, dogfish, skates and rays. WGEF evaluated sampling plans and their usefulness for providing assessment data (ICES, 2004).

In 2005, WGEF came under ACFM and was given the task of supporting the advisory process. This was because ICES has been asked by the European Commission to provide advice on certain species. This task was partly achieved by WGEF in that preliminary assessments were provided for spurdog, kitefin shark, thornback ray (North Sea) and deep-water sharks (combined). ACFM produced advice on these species, as well as for basking shark and porbeagle, based on the WGEF Report. A standard reporting and presentation format was adopted for catch data and best estimates of catch by species were provided for the first time (ICES, 2005).

In 2006, work continued on refining landings data and collating available biological data (ICES, 2006). Work was begun on developing standard reporting formats for length–frequency, maturity and CPUE data.

In 2007, WGEF met in Galway, with the demersal elasmobranchs of three ecoregions (North Sea, Celtic Seas and Bay of Biscay/Iberian waters) subject to more detailed study and assessment (ICES, 2007), with special emphasis on skates (given that these are generally the more commercially valuable demersal elasmobranchs in shelf seas). It should be noted, however, that though there have been some historical tagging studies (and indeed there are also on-going tagging and genetic studies), current knowledge of the stock structure and identity for many of these species is poor, and in most instances the assumed stock area equates with management areas.

WGEF met twice in 2008, firstly in parallel with WGDEEP (March 2008) to update assessments and advice for deep-water sharks and demersal elasmobranchs, and then with the ICCAT shark subgroup in Madrid (September 2008) to address North Atlantic stocks of shortfin mako and blue shark, and to further refine data available for the NE Atlantic stock of porbeagle (ICES, 2008).

In June 2009, WGEF held a joint meeting with the ICCAT SCRS Shark subgroup at ICES headquarters (Copenhagen). This meeting successfully pooled all available data on North Atlantic porbeagle stocks (ICES, 2009). In addition, updated assessments were carried out for North Sea, Celtic Seas, and Biscay and Iberian demersal elasmobranchs and for the deep-water sharks *Centrophorus squamosus* and *Centroscymnus coelolepis*. A three-year assessment schedule was also agreed.

In June 2010, WGEF met in Horta, Portugal. This meeting was a full assessment meeting and stock updates were carried out for 19 species or species groups (ICES, 2010b), with draft advice provided for eight stocks. In addition, three special requests from the EC, relating to new advice on five elasmobranch species, were answered.

In June 2011, WGEF met at ICES Headquarters Copenhagen. Although this was not an advice year, advice was provided for *Squalus acanthias*. This was the result of a benchmark assessment of this species carried out via correspondence during spring 2011. The updated model was used to provide F_{MSY}-based advice for the first time. A special request from NEAFC, on sharks and their categorisation by habitat was also addressed (ICES, 2011b).

In June 2012, WGEF met at IPMA in Lisbon (ICES, 2012b). This meeting was a full assessment meeting during which both stock updates and draft advice were provided. Two special requests, one from NEAFC and the other from the NWWRAC (via the EC), were also answered. WGEF also met in Lisbon the following year (ICES, 2013a) with preparatory work and exploratory analyses conducted, in addition to addressing some special advice requests from the EU.

From 2014, it was decided with ICES that advice would be staggered, with the main stocks divided across alternating years and with advice for prohibited and most of the zero-TAC stocks done once every four years. In 2014, WGEF assessed and provided draft advice for skates (Rajidae) in the Celtic Seas and Biscay-Iberian ecoregions (ICES, 2014), and the following year (2015) WGEF examined skates in the North Sea ecoregion and Azorean waters, as well as various sharks: Portuguese dogfish, leafscale gulper shark, kitefin shark, smooth-hounds, tope, catsharks, angel shark, porbeagle and basking shark (ICES, 2015).

Overall the working group has been successful in maintaining participation from a wide range of countries, although the number of active participants declined slightly in 2016, for various reasons. Nevertheless, over the longer-term, attendance at WGEF has been at a stable level in recent years, with participation from quantitative assessment scientists, fishery managers, survey scientists and elasmobranch biologists.

In 2020 and 2021, WGEF met online due to COVID-19 restrictions. For the 2020 working group, data submission and processing had been altered to reduce issues in terms of data call interpretation as well as the delivery of non-uniform data sets. The WGEF 2020 data were submitted to InterCatch for the first time, extracted and processed using R-code available in TAF. Next landings data are collated to the landings spreadsheet containing the historical landings data. This process was repeated in 2021 using the 2020 landings data. Furthermore, issues in terms of harmonisation of fleet names, stock codes and species codes of historic landings data was performed. Also, an important step towards the use of discard data in the advice was taken. Available discard data on the accessions folder and those submitted to InterCatch for the years 2019 and 2020 were combined into a discard table. Next steps should include an automated process of cleaning up the data, having a quality assessment and control of the submitted discard data.

1.3 Planning of the work of the group

Given the large number of stocks that WGEF addresses, WGEF and the ICES Secretariat have developed the following timeframe for advice.

In 2019, the following species and stocks with quadrennial advice were addressed (Table 1.1). These stocks will be addressed again in 2023:

- Common skate in the greater North Sea ecoregion
- Starry ray in the greater North Sea ecoregion
- Leafscale gulper shark in the Northeast Atlantic;
- Kitefin shark in the Northeast Atlantic;
- Portuguese dogfish in the Northeast Atlantic;
- Angel shark in the Northeast Atlantic;
- Porbeagle in the Northeast Atlantic;
- Basking shark in the Northeast Atlantic;
- Thresher sharks in the Northeast Atlantic;
- White skate in the Northeast Atlantic.

In 2020, the following species and stocks were addressed for advice (Table 1.2). These stocks will be addressed again in 2022:

- Spurdog in the Northeast Atlantic;
- Skates and rays (Rajidae) in the Celtic Seas (ICES subareas 6 and 7 except Division 7.d);[1]
- Skates and rays (Rajidae) in the Bay of Biscay and Iberian Coast (ICES Subarea 8 and Division 9.a).

In 2021, the following species and stocks were assessed and advice drafted (Table 1.3). These stocks will be addressed again in 2023:

- Skates and rays (Rajidae) in the Greater North Sea, (including Skagerrak, Kattegat and eastern Channel) (eight ICES assessment units including ‘other rays and skates’);
- Skates and rays (Rajidae) in the Azores and Mid-Atlantic Ridge (mainly *R. clavata*);
- Smooth-hounds in the Northeast Atlantic;
- Tope in the Northeast Atlantic;
- Catshark stocks in the Northeast Atlantic (seven ICES stock assessment units);

[1] Note: Skate stocks that straddle divisions 7.d and 7.e are included within the Celtic Sea section and advice. Skate species that straddle Division 4.c and Division 7.d are included within the North Sea section and advice.

Table 1.1. Elasmobranch stocks with quadrennial assessments and advice carried out in 2019

ICES stock code	Stock name	Ecoregion	Advice updated	Advice
rjb.27.3a4	Common skate (*Dipturus batis*-complex) in Subarea 4 and Division 3.a (North Sea and Skagerrak)	North Sea	2019	Quadrennial
rjr.27.23a4	Starry ray (*Amblyraja radiata*) in Subareas 2, 3.a and 4 (Norwegian Sea, Skagerrak, Kattegat and North Sea)	North Sea	2019	Quadrennial
agn.27.nea	Angel shark (*Squatina squatina*) in the Northeast Atlantic	Widely distributed and migratory stocks	2019	Quadrennial
bsk.27.nea	Basking shark (*Cetorhinus maximus*) in the Northeast Atlantic	Widely distributed and migratory stocks	2019	Quadrennial
cyo.27.nea	Portuguese dogfish (*Centroscymnus coelolepis*) in the Northeast Atlantic	Widely distributed and migratory stocks	2019	Quadrennial
guq.27.nea	Leafscale gulper shark (*Centrophorus squamosus*) in the Northeast Atlantic	Widely distributed and migratory stocks	2019	Quadrennial
por.27.nea	Porbeagle (*Lamna nasus*) in the Northeast Atlantic	Widely distributed and migratory stocks	2019	Quadrennial
rja.27.nea	White skate (*Rostroraja alba*) in the Northeast Atlantic	Widely distributed	2019	Quadrennial
sck.27.nea	Kitefin shark (*Dalatias licha*) in the Northeast Atlantic	Widely distributed and migratory stocks	2019	Quadrennial
thr.27.nea	Thresher sharks (*Alopias* spp.) in Subareas 10, 12, Divisions 7.c-k, 8.d-e, and Subdivisions 5.b.1, 9.b.1, 14.b.1 (Northeast Atlantic)	Widely distributed	2019	Quadrennial

Table 1.2. Elasmobranch stocks for which assessments and advice was provided in 2020.

ICES stock code	Stock name	Ecoregion	Advice updated	Advice
dgs.27.nea	Spurdog (*Squalus acanthias*) in the Northeast Atlantic	Widely distributed	2020	Biennial
raj.27.67a-ce-h	Other skates and rays in Subareas 6 and 7 (excluding 7.d)	Celtic Seas	2020	Biennial
raj.27.89a	Other skates and rays in Subarea 8 and Division 9.a (Bay of Biscay and Atlantic Iberian waters)	Bay of Biscay and Iberian coast	2020	Biennial
rjb.27.67a-ce-k	Common skate complex (flapper skate (*Dipturus batis*) and blue skate (*Dipturus intermedius*)) in Subareas 6 and 7 (excluding 7.d)	Celtic Seas	2020	Biennial
rjb.27.89a	Common skate (*Dipturus batis*-complex) in Subarea 8 and Division 9.a (Bay of Biscay and Atlantic Iberian waters)	Bay of Biscay and Iberian coast	2020	Biennial
rjc.27.6	Thornback ray (*Raja clavata*) west of Scotland (Subarea 6)	Celtic Seas	2020	Biennial
rjc.27.7afg	Thornback ray (*Raja clavata*) in Divisions 7a.f.g (Irish and Celtic Sea)	Celtic Seas	2020	Biennial
rjc.27.7e	Thornback ray (*Raja clavata*) in Division 7.e (Western English Channel)	Celtic Seas	2020	Biennial
rjc.27.8	Thornback ray (*Raja clavata*) in Subarea 8 (Bay of Biscay and Cantabrian Sea)	Bay of Biscay and Iberian coast	2020	Biennial
rjc.27.9a	Thornback ray (*Raja clavata*) in Division 9.a (west of Galicia, Portugal, and Gulf of Cadiz)	Bay of Biscay and Iberian coast	2020	Biennial

ICES stock code	Stock name	Ecoregion	Advice updated	Advice
rje.27.7de	Small-eyed ray (*Raja microocellata*) in the English Channel (Divisions 7.d.e)	Celtic Seas	2020	Biennial
rje.27.7fg	Small-eyed ray (*Raja microocellata*) in Divisions 7.f.g (Bristol Channel)	Celtic Seas	2020	Biennial
rjf.27.67	Shagreen ray (*Leucoraja fullonica*) in Subareas 6 and 7 (Celtic Sea and West of Scotland)	Celtic Seas	2020	Biennial
rjh.27.7afg	Blonde ray (*Raja brachyura*) in Divisions 7.a.f.g (Irish and Celtic Sea)	Celtic Seas	2020	Biennial
rjh.27.7e	Blonde ray (*Raja brachyura*) in Division 7.e (western English Channel)	Celtic Seas	2020	Biennial
rjh.27.9a	Blonde ray (*Raja brachyura*) in Division 9.a (west of Galicia, Portugal, and Gulf of Cadiz)	Bay of Biscay and Iberian coast	2020	Biennial
rji.27.67	Sandy ray (*Leucoraja circularis*) in Subareas 6 and 7 (Celtic Sea and West of Scotland)	Celtic Seas	2020	Biennial
rjm.27.67bj	Spotted ray (*Raja montagui*) in Subarea 6 and Divisions 7.b.j (west of Scotland and Ireland)	Celtic Seas	2020	Biennial
rjm.27.7ae-h	Spotted ray (*Raja montagui*) in Divisions 7.a.e.f.g.h (southern Celtic seas)	Celtic Seas	2020	Biennial
rjm.27.8	Spotted ray (*Raja montagui*) in Subarea 8 (Bay of Biscay and Cantabrian Sea)	Bay of Biscay and Iberian coast	2020	Biennial
rjm.27.9a	Spotted ray (*Raja montagui*) in Division 9.a (west of Galicia, Portugal, and Gulf of Cadiz)	Bay of Biscay and Iberian coast	2020	Biennial
rjn.27.678abd	Cuckoo ray (*Leucoraja naevus*) in Subareas 6 and 7 (Celtic Sea and West of Scotland) and Divisions 8.a.b.d (Bay of Biscay)	Celtic Seas/Biscay	2020	Biennial
rjn.27.8c	Cuckoo ray (*Leucoraja naevus*) in Division 8.c (Cantabrian Sea)	Bay of Biscay and Iberian coast	2020	Biennial
rjn.27.9a	Cuckoo ray (*Leucoraja naevus*) in Division 9.a (west of Galicia, Portugal, and Gulf of Cadiz)	Bay of Biscay and Iberian coast	2020	Biennial
rju.27.7bj	Undulate ray (*Raja undulata*) in Divisions 7.b.j (Southwest of Ireland)	Celtic Seas	2020	Biennial
rju.27.7de	Undulate ray (*Raja undulata*) in Divisions 7.d.e (English Channel)	Celtic Seas	2020	Biennial
rju.27.8ab	Undulate ray (*Raja undulata*) in Divisions 8.a.b (Bay of Biscay)	Bay of Biscay and Iberian coast	2020	Biennial
rju.27.8c	Undulate ray (*Raja undulata*) in Divisions 8.c (Cantabrian Sea)	Bay of Biscay and Iberian coast	2020	Biennial
rju.27.9a	Undulate ray (*Raja undulata*) in Division 9.a (west of Galicia, Portugal, and Gulf of Cadiz)	Bay of Biscay and Iberian coast	2020	Biennial

Table 1.3. Elasmobranch stocks scheduled for assessments and advice in 2021.

ICES stock code	Stock name	Ecoregion	Advice updated	Advice
gag.27.nea	Tope (*Galeorhinus galeus*) in the Northeast Atlantic	Widely distributed and migratory stocks	2019	Biennial
raj.27.3a47d	Other skates and rays in the North Sea ecoregion (Subarea 4, and Divisions 3.a and 7.d)	North Sea	2019	Biennial
raj.27.1012	Rays and skates (mainly thornback ray) in the Azores and Mid-Atlantic Ridge	Widely distributed and migratory stocks	2019	Biennial
rjc.27.3a47d	Thornback ray (*Raja clavata*) in Subarea 4, and Divisions 3.a and 7.d (North Sea, Skagerrak, Kattegat and eastern English Channel)	North Sea	2019	Biennial
rjh.27.4a6	Blonde ray (*Raja brachyura*) in Division 4a and Subarea 6 (Northern North Sea and west of Scotland)	North Sea	2019	Biennial
rjh.27.4c7d	Blonde ray (*Raja brachyura*) in Divisions 4c and 7.d (Southern North Sea and eastern English Channel)	North Sea	2019	Biennial
rjm.27.3a47d	Spotted ray (*Raja montagui*) in Subarea 4, and Divisions 3.a and 7.d (North Sea, Skagerrak, Kattegat, and Eastern English Channel)	North Sea	2019	Biennial
rjn.27.3a4	Cuckoo ray (*Leucoraja naevus*) in Subarea 4 and Division 3.a (North Sea and Skagerrak and Kattegat)	North Sea	2019	Biennial
sdv.27.nea	Starry smooth-hound (*Mustelus* spp.) in the Northeast Atlantic	Widely distributed and migratory stocks	2019	Biennial
sho.27.67	Black-mouth dogfish (*Galeus melastomus*) in Subareas 6 and 7 (Celtic Sea and West of Scotland)	Celtic Seas	2019	Biennial
sho.27.89a	Black-mouth dogfish (*Galeus melastomus*) in in Subarea 8 and Division 9.a (Bay of Biscay and Atlantic Iberian waters)	Bay of Biscay and Iberian seas	2019	Biennial
syc.27.3a47d	Lesser-spotted dogfish (*Scyliorhinus canicula*) in Subarea 4, and Divisions 3.a and 7.d (North Sea, Skagerrak, Kattegat, and Eastern English Channel)	North Sea	2019	Biennial
syc.27.67a-ce-j	Lesser-spotted dogfish (*Scyliorhinus canicula*) in Subarea 6 and Divisions 7.a–c. e–j (Celtic Seas and west of Scotland)	Celtic Seas	2019	Biennial
syc.27.8abd	Lesser-spotted dogfish (*Scyliorhinus canicula*) in Divisions 8.a,b,d (Bay of Biscay)	Bay of Biscay and Iberian seas	2019	Biennial
syc.27.8c9a	Lesser-spotted dogfish (*Scyliorhinus canicula*) in Divisions 8.c and 9.a (Atlantic Iberian waters)	Bay of Biscay and Iberian seas	2019	Biennial
syt.27.67	Greater-spotted dogfish (*Scyliorhinus stellaris*) in Subareas 6 and 7 (Celtic Sea and West of Scotland)	Celtic Seas	2019	Biennial

1.4 ICES approach to F_{MSY}

Most elasmobranch species are slow growing, with low population productivity. Some species (e.g. basking shark) are on several lists of 'threatened' or 'endangered' species. They may also be listed under international trade agreements such as the Convention on the International Trade on Endangered Species (CITES), which may place limitations on fishing for or trade in these species. Because of this, it is not believed that F_{MSY} is an appropriate or achievable target in all cases, particularly in the short term. However, the ICES F_{MSY} methodology has evolved in recent years. For example, new methods that are more appropriate for data-deficient stocks have been developed, and there is a greater interest in considering generation time into such methods and for the provision of advice. The generation time of elasmobranchs is often much longer than most teleosts. For each assessed stock, the ICES precautionary approach is considered, and the group's approach and considerations are outlined in the stock summary sheets of the advice. Since 2017, WGEF has explored several data-poor assessment methods to selected ray stocks. These methods produced promising results, but will require some adjustment to account for elasmobranch life history and fisheries dynamics. In 2018 and 2019, progress was made with applying MSY proxies to elasmobranch stocks. Following the recommendations made in 2018, WGEF further explored the application of proxy MSY reference points to elasmobranch fishes. Full information on this analysis is available in Miethe (2019, WGEF WD, see Annex 6). In 2020, an exploratory analysis of two different production models applied to North Sea and English Channel Rajidae stocks was presented. The analysis highlighted the importance of improving the availability of catch data and as such touches on the issue of having reliable discard estimates.

1.5 Community plan of action for sharks

An Action Plan for the Conservation and Management of Sharks (EU, 2009) was adopted by the European Commission in 2009. Further details on this plan and its relevance to WGEF can be found in an earlier report (ICES, 2009).

1.6 Conservation advice

Several terms are used to define stock status, particularly at low levels. Some of these terms mean different things to different people. Therefore, WGEF takes this opportunity to define how terms are used within this report, and also how WGEF believe these terms should be used when providing advice.

In addition, several elasmobranch species are listed as 'prohibited species' or as species that cannot be retained in European Council Regulations fixing annual fishing opportunities (CEC, 2021). Although this may be appropriate, WGEF believes that this status should only be used for long-term conservation, whilst a (near) zero TAC may be more appropriate for short-term management.

These ideas are discussed in detail below.

Extinction vs. extirpation

Extinction is defined as "*The total elimination or dying out of any plant or animal species, or a whole group of species, worldwide*" (Chambers Dictionary of Science and Technology), yet increasingly the term 'extinct' is used in conservation and scientific literature to highlight the disappearance of a species from a particular location or region, even if the area is at the periphery of the main geographical range.

Additionally, some of the studies that have reported a species to be (locally or regionally) 'extinct' can be based on limited data, with supporting data often neither spatially nor temporally comprehensive enough to confirm the loss, especially with regards to species that are wide-ranging, small-bodied and/or cryptic, or distributed in habitats that are difficult to survey.

In terms of a standardized approach to the terminology of lost species, WGEF consider the following:

Extinct: When an animal or plant species has died out over its entire geographical range.

Extirpated: When an animal or plant species has died out over a defined part of its range, from where it was formerly a commonly occurring species. This loss should be due, whether directly or indirectly, to anthropogenic activities.

If anthropogenic activities are not considered to have affected the loss of the species, then the species should be considered to have 'disappeared' or been lost from the area in question. The term 'extirpated' should also be used to identify the loss of the species from part of the main geographical range or habitat, and therefore be distinguished from a contraction in the range of a species, where it has been lost from the fringes of its distribution or suboptimal habitat.

Additionally, the terms 'extinct' and 'extirpated' should be used when there has been sufficient, appropriate survey effort (i.e. operating at the relevant temporal and spatial scale and with an appropriate survey or census method) to declare the species extinct/extirpated. Prior to this time, these terms could be prefixed near- or presumed.

Presumed extinct/extirpated should be used when the species has not been recorded in available survey data (which should operate at an appropriate temporal and spatial scale), but when dedicated species-specific surveys have not been undertaken.

Near extinct/extirpated should be used when there are isolated reports of the species existing in the geographical area of interest.

In terms of ICES advice, the term 'extinct' was used in both 2005 and 2006 to describe the status of angel shark in the North Sea; although since 2008 the term 'extirpated' has been used.

The utility of the Prohibited species list on TAC and quotas regulations

The list of prohibited species on the TACs and quotas regulations (e.g. EC, 2021) is an appropriate measure for trying to protect the marine fish of highest conservation importance, particularly those species that are also listed on CITES and various other conservation conventions. Additionally, there should be sufficient concern over the population status and/or impacts of exploitation that warrants such a long-term conservation strategy over the whole management area.

There are some species that would fall into this category. For example, white shark and basking shark are both listed on CITES and some European nations have given legal protection to these species. Angel shark has also been given legal protection in UK.

It should also be recognized that some species that are considered depleted in parts of their range may remain locally abundant in some areas, and such species might be able to support low levels of exploitation. From a fisheries management viewpoint, advice for a zero or near-zero TAC, or for no target fisheries, is very different from a requirement for 'prohibited species' status, especially as a period of conservative management may benefit the species and facilitate a return to commercial exploitation in the short term.

Additionally, there is a rationale that a list of prohibited species should not be changing regularly, as this could lead to confusion for both the fishing and enforcement communities. The STECF meeting on management of skates and rays has recommended issuing guidelines for the inclusion and removal of species on the prohibited species list (STECF, 2017).

In 2009 and 2010, undulate ray, *Raja undulata* was moved on to the prohibited species list. This had not been advised by ICES. Following a request from commercial fishers, the European Commission asked ICES to give advice on this listing. ICES reiterated that undulate ray would be better managed under local management measures and that there was no justification for placing undulate ray on the prohibited species list. There have been subsequent changes in the listing of this species. It was removed from the Prohibited Species List for Subarea 7 in 2014 (albeit as a species that cannot be retained or landed). In 2015, undulate ray was only maintained in the prohibited species list in subareas 6 and 10. Small TACs were established for stocks in the English Channel and Bay of Biscay in 2015 and for the stock in the Iberian ecoregion in 2016. During the 2018 meeting, the advice for 2016–2017 was recalculated following a request from France (ICES, 2018b).

In 2019, the list of prohibited species in the TACs and quota regulations was amended. An extensive list of prohibited species, including white shark, basking shark and hammerhead sharks have been taken up in the regulation on the conservation of fisheries resources and the protection of marine ecosystems through technical measures (EU regulation 2019/1241).

1.7 Sentinel fisheries

ICES advice for several elasmobranch stocks suggests that their fisheries should, for example "*consist of an initial low* (level) *scientific fishery*". In discussions of such fisheries, WGEF would suggest that a 'sentinel fishery' is a science-based data collection fishery conducted by commercial fishing vessel(s) to gather information on a specific fishery over time using a commercial gear but with standardized survey protocols. Sentinel fisheries would:

- Operate with a standardized gear, defined survey area, and standardized index of effort;
- Aim to provide standardized information on those stocks that may not be optimally sampled by existing fishery-independent surveys;
- Include a limited number of vessels;
- Be subject to trip limits and other technical measures from the outset, in order to regulate fishing effort/mortality in the fishery;
- Carry scientific observers on a regular basis (e.g. for training purposes) and be collaborative programmes with scientific institutes;
- Assist in biological sampling programmes (including self-sampling and tagging schemes);
- Sampling designs, effort levels and catch retention policy should be agreed between stakeholders, national scientists and the relevant ICES assessment expert group.

1.8 Mixed fisheries regulations

Apart from TAC regulations, several ICES divisions have fish stocks subject to recovery plans, including the cod recovery plan, hake recovery plan, etc.

As several elasmobranch stocks, particularly skates and rays, are caught in mixed fisheries within these areas catches of elasmobranchs may be limited by restrictive effort limitations because of these plans. In general, these are not referred to within the text, but must be taken into consideration when looking at landings trends from within these areas.

1.9 Current ICES expert groups of relevance to the WGEF

Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK)

Several elasmobranchs are taken in North Sea demersal fisheries, including spurdog (Section 2), tope (Section 10), various skates (Section 15) and starry smooth-hound (Section 21).

WGNSSK should note that the Greater Thames Estuary is the main part of the North Sea distribution of thornback ray *Raja clavata* and may also be an important nursery ground for some small shark species, such as tope and starry smooth-hound. Thornback ray is an important species in ICES Division 4.c, and is taken as bycatch in fisheries targeting sole (e.g. trawl and gillnet), cod (e.g. trawl, gillnet and longline), as well as in targeted fisheries.

The Wash may also be an area of ecological importance for some elasmobranchs, including thornback ray and tope.

Working Group for the Celtic Seas Ecoregion (WGCSE)

Several elasmobranchs are taken in the waters covered by WGCSE, including spurdog (Section 2), tope (Section 10), various skates and rays (Section 18) and starry smooth-hound (Section 21).

WGCSE should note that common skate *Dipturus batis*-complex, which has declined in many inshore areas of northern Europe, may be locally abundant in parts of ICES Division 6.a and the deeper waters of the Celtic Sea (Division 7.h-j). Thornback ray is abundant in parts of the Irish Sea, especially Solway Firth, Liverpool Bay and Cardigan Bay. The Lleyn Peninsula is an important ground for greater-spotted dogfish *Scyliorhinus stellaris*. WGSCE should also note that the Bristol Channel is of high local importance for small-eyed ray *Raja microocellata*, as well as being an important nursery ground for some small sharks (e.g. starry smooth-hound and tope) and various skates.

Angel shark (Section 22) was formerly abundant in parts of Cardigan Bay, the Bristol Channel and Start Bay, and is now observed very rarely. Similarly, white skate (Section 23) was historically present in this ecoregion, and may be near-extirpated from most parts of the ecoregion.

Working Group on the Biology and Assessment of Deep-sea Fisheries Resources (WGDEEP)

In 2008, WGEF met in parallel with WGDEEP in order to assess and provide advice on deep-water sharks (see sections 3–5). In February 2010, WGDEEP held a benchmark assessment of deep-water stocks (WKDEEP; ICES, 2010a). Two WGEF members attended in order to carry out an assessment of the deep-water shark species *Centrophorus squamosus* and *Centroscymnus coelolepis*. Considerable progress was made in robust construction of a plausible catch and effort history for both species. A novel approach to assessing such species as deep-water sharks was presented at the meeting using a subset of the data on Portuguese dogfish and was agreed by WKDEEP to be a highly promising approach, pending the acceptable reconstruction of the aforementioned catch and effort data. Further development and possible future application of the method is to be encouraged. Several members of WGEF also attend WGDEEP, so facilitating the exchange of knowledge between the two expert groups.

International Bottom-trawl Survey Working Group (IBTSWG) and Working Group on Beam Trawl Surveys (WGBEAM)

IBTSWG continue to provide maps of the distribution of a variety of demersal elasmobranchs from the IBTS surveys in the North Sea and western areas. WGEF consider that these plots provide useful information and hope that IBTSWG will continue to provide these plots as routine outputs in the future. WGBEAM carries out some analysis of catch rates and distribution of certain skate species from beam trawl surveys in the North Sea and Celtic Seas ecoregions. Such analyses are very useful for WGEF.

There are some inaccuracies in the identifications of some skates in various trawl surveys, as well as some recent taxonomic revisions. Hence, more collaborative studies and exchange between WGEF and WGBEAM to address such issues is encouraged.

Workshop on the Inclusion of Discard Survival in Stock Assessments (WKSURVIVE)

The first workshop is planned in February 2021. Important objectives of this Workshop for WGEF is to explore the incorporation of discard survival estimates in stock assessments as well as to review the various approaches taken to integrate discard estimates in current assessments in the context of applying discard survival estimates.

One of the recurring issues in WGEF is the uncertainty in discard data as a result of the high number of discrepancies between years and inconsistent or missing data. Despite having had two dedicated workshops on the use of discard data in stock assessments (WKSHARK 3 (ICES, 2017) and WKSHARK5 (ICES, 2020a)), it is still not possible to move forward on this issue. In addition, given the expected high survival of elasmobranchs, catch data (i.e. landings and estimated discards) will not equal dead removals. Hence the importance to understand the survival rate of discarded elasmobranchs in order to obtain a separate estimates for dead and surviving discards.

WGEF recommends to initiate a collaborative effort to address issues about the collection and registration of discard data and to evaluate the use of discard data, including survivability, for the application in future stock assessments. Hence, WGEF recommends members of the group to join WKSURVIVE.

1.10 Other meetings of relevance to WGEF

1.10.1 ICCAT

WGEF have conducted joint-meetings and assessments with ICCAT in 2008 (Madrid) and 2009 (ICES headquarters). These meetings were useful in pooling information on highly migratory pelagic shark species, including porbeagle, blue shark and shortfin mako. It is intended that these collaborations continue to usefully assess and update knowledge of pelagic shark species. ICCAT shark specialist subgroup also recommends maintaining links and sharing data with WGEF.

In 2012, a representative of WGEF attended the ICCAT Ecological Risk Assessment and shortfin mako stock assessment in Faro, Portugal. Data from this meeting were used in the WGEF account of shortfin mako (Section 9). In 2015, representatives of WGEF participated at the ICCAT blue shark stock assessment that was held in Lisbon, Portugal.

In 2016, representatives of ICCAT and WGEF attended the ICES Workshop to compile and refine catch and landings of elasmobranchs (WKSHARKS; ICES, 2016).

The ICCAT Shark Species Group held an intercessional meeting at Madeira in April 2016 (ICCAT, 2016). The ICCAT Shark Species Group intends to update stock assessments of Atlantic stocks of shortfin mako in 2017. ICCAT (2016) also suggested that updated porbeagle assessments should be undertaken in 2019.

A joint ICCAT-ICES meeting was planned for WGEF 2020, but due to COVID-19 measures an in-person meeting was not possible. ICCAT organized an online Atlantic porbeagle stock assessment meeting which was attended by members of WGEF. The meeting focused on the Northwest

Atlantic stock, and the Southwest and Southeast stocks. In 2022, the Northeast Atlantic stock will be benchmarked requiring a cooperative effort from ICCAT and WGEF.

WGEF considers that further collaborative meetings with the ICCAT Shark Species Group should continue. There is an initiative to carry out a joint ICCAT-ICES meeting to assess porbeagle and to invite ICCAT members in the upcoming porbeagle (por.27.nea) benchmark in 2022. A joint ICCAT-ICES meeting could also usefully address the data and assessment of thresher shark *Alopias* spp.

1.10.2 General Fisheries Commission for the Mediterranean (GFCM)

From 2010 to 2013, the GFCM carried out a programme to improve the knowledge and assess the status of elasmobranchs in the Mediterranean and the Black Sea. The main outcomes of this four-year programme were three meetings and two publications:

1. Expert Meeting on the status of elasmobranchs in the Mediterranean and Black Sea (Sfax, Tunisia, 20–22 September 2010);
2. Workshop on stock assessment of selected species of elasmobranchs (Brussels, Belgium, 12–16 December 2011);
3. Workshop on age determination (Antalya, Turkey, 8–12 October 2012);
4. Bibliographic review to sum up the information gathered during the above mentioned meetings (Bradai *et al.*, 2012); and
5. Publication of a technical manual on elasmobranch age determination (Campana, 2014).

In 2013, the GFCM decided to develop a three-year extension of this programme including the:

1. Preparation of a draft proposal on practical options for mitigating bycatch for the most impacting gears in the Mediterranean and Black Sea;
2. Production and dissemination of guidelines on good practices to reduce the mortality of sharks and rays caught incidentally by artisanal fisheries;
3. Development of studies on growth, reproduction, population genetic structure and post-released mortality and identification of critical areas (nurseries) at national or regional level;
4. Preparation of factsheets and executive summaries for some commercial species presenting identification problems;
5. Assessment of the impact of anthropogenic activities other than fisheries on the observed decline of certain sharks and ray populations;
6. Implementation of a pilot tagging programme for pelagic sharks.

WGEF consider that ICES and the GFCM would benefit from improved interaction due to the overlap in the distribution of certain stocks, and also in comparing stock assessment methods for data-limited stocks.

1.11 Relevant biodiversity and conservation issues

ICES work on elasmobranch fish is becoming increasingly important as a source of information to various multilateral environmental agreements concerning the conservation status of some species. Table 1.3 lists species occurring in the ICES area that are considered within these fora. An increasing number of elasmobranchs are ‘prohibited’ species in European fisheries regulations (CEC, 2019 and 2021), and these are summarised in Table 1.4.

Additionally, whilst not forming the basis of a legal instrument, the International Union for Conservation of Nature (IUCN) conduct Red List assessments of many species, including elasmobranchs, which has been undertaken at North-East Atlantic (Gibson *et al.*, 2008), Mediterranean (Cavanagh and Gibson, 2007; Abdul Malak *et al.*, 2011) and European scales (Nieto *et al.*, 2015). IUCN listings are summarised in the relevant species sections and are not discussed further in this section of the report.

1.11.1 OSPAR Convention

The OSPAR Convention (www.ospar.org) guides international cooperation on the protection of the marine environment of the Northeast Atlantic. It has 15 Contracting Parties and the European Commission represents the European Union. The OSPAR list of Threatened and/or Declining Species and Habitats, developed under the OSPAR Strategy on the Protection and Conservation of the Ecosystems and Biological Diversity of the Maritime Area, provides guidance on future conservation priorities and research needs for marine biodiversity at risk in the region. To date, eleven elasmobranch species are listed (Table 1.3), either across the entire OSPAR region or in areas where they were perceived as declining. Background Documents summarizing the status of these species are available (OSPAR Commission, 2010).

In 2020, ICES was requested to review and update OSPAR status assessments for stocks of listed shark, skates and rays in support of the OSPAR Quality Status Report 2023 (QSR2023) (WKSTATUS, ICES, 2020b). WKSTATUS has commented on whether the species continues to justify inclusion in the OSPAR List. The group concluded that it was not possible to ascertain a change for white skate, the deep-water species, basking shark and angel shark. Whereas the common blue skate appears to be slowly improving, the flapper skate may be more vulnerable to overfishing. In addition, it is recommended that both species are considered and listed separately. For porbeagle and spurdog assessment methodologies have improved and there appears to be small improvements in the population status, but this is as yet not fully quantified for porbeagle in the entire OSPAR area. Thornback and spotted rays have increased in abundance in the areas where they were previously considered depleted, and are considered not to continue to justify inclusion in the OSPAR List for this criterion. However, measures to address selectivity and discard survival should be further developed for these species.

1.11.2 Convention on the Conservation of Migratory Species (CMS)

CMS recognizes the need for countries to cooperate in the conservation of animals that migrate across national boundaries, if an effective response to threats operating throughout a species' range is to be made. The Convention actively promotes concerted action by the range states of species listed on its Appendices. The CMS Scientific Council has determined that 35 shark and ray species, globally, meet the criteria for listing in the CMS Appendices (Convention on Migratory Species, 2007). Table 1.3 lists Northeast Atlantic elasmobranch species that are currently included in the Appendices.

CMS Parties should strive towards strict protection of endangered species on Appendix I, conserving or restoring their habitat, mitigating obstacles to migration and controlling other factors that might endanger them. The range states of Appendix II species (migratory species with an unfavourable conservation status that need or would significantly benefit from international co-operation) are encouraged to conclude global or regional agreements for their conservation and management.

CMS now has a Sharks MOU, comprising an Advisory Committee (AC) and Intercessional Working Group (IWG).

1.11.3 Convention on International Trade in Endangered Species (CITES)

CITES was established in recognition that international cooperation is essential to the protection of certain species from overexploitation through international trade. It creates an international legal framework for the prevention of trade in endangered species of wild fauna and flora, and for the effective regulation of international trade in other species which may become threatened in the absence of such regulation.

Species threatened with extinction can be listed on Appendix I, which basically bans commercial, international trade in their products. Appendix II includes "*species not necessarily threatened with extinction, but in which trade must be controlled in order to avoid utilization incompatible with their survival*". Trade in such species is monitored closely and allowed if exporting countries can provide evidence that such trade is not detrimental to wild populations of the species.

Resolution Conf. 12.6 encourages parties to identify endangered shark species that require consideration for inclusion in the Appendices if their management and conservation status does not improve. Decision 13.42 encourages parties to improve data collection and reporting of catches, landings and trade in sharks (at species level where possible), to build capacity to manage their shark fisheries, and to take action on several species-specific recommendations from the Animals Committee (CITES, 2009).

1.11.4 Convention on the Conservation of European Wildlife and Natural Habitats (Bern convention)

The Bern Convention is a regional convention that provides a binding, international legal instrument that aims to conserve wild flora, fauna and natural habitats. Appendix II (or III) lists strictly protected (or protected) species of fauna (sometimes identified for the Mediterranean Sea only). Contracting Parties should "*take appropriate and necessary legislative and administrative measures to ensure the special protection of the wild fauna species specified in Appendix II*" and "*protection of the wild fauna species specified in Appendix II*".

Table 1.3. Elasmobranch species listed by Multilateral Environmental Agreements. Source; OSPAR (http://www.ospar.org/), CITES (https://cites.org/), CMS (http://www.cms.int/) and Bern Convention (http://www.coe.int/t/dg4/cultureheritage/nature/bern/default_en.asp).

Family	Species	Multinational Environmental Agreement			
		OSPAR	CMS	CITES	Bern
Squalidae	Spurdog *Squalus acanthias*	✓	App II (northern hemisphere populations		
Centrophoridae	Gulper shark *Centrophorus granulosus*	✓			
	Leafscale gulper shark *Centrophorus squamosus*	✓			
Somniosidae	Portuguese dogfish *Centroscymnus coelolepis*	✓			
Squatinidae	Angel shark *Squatina squatina*	✓			App III (Med)
Rhincodontidae	Whale shark *Rhincodon typus*		App II	App II	
Alopiidae	Pelagic thresher *Alopias pelagicus*		App II	App II	
	Bigeye Thresher *Alopias superciliosus*		App II	App II	
	Common Thresher *Alopias vulpinus*		App II	App II	
Cetorhinidae	Basking shark *Cetorhinus maximus*	✓	App I and II	App II	App II (Med)
Lamnidae	White shark *Carcharodon carcharias*		App I and II	App II	App II (Med)
	Shortfin mako shark *Isurus oxyrinchus*		App II		App III (Med)
	Longfin mako shark *Isurus paucus*		App II		
	Porbeagle shark *Lamna nasus*	✓	App II	App II	App III (Med)
Carcharhinidae	Silky shark *Carcharhinus falciformis*		App II	App II	
	Oceanic white-tip *Carcharhinus longimanus*			App II	
	Blue shark *Prionace glauca*				App III (Med)
Sphyrnidae	Scalloped hammerhead *Sphyrna lewini*		App II	App II	
	Great hammerhead *Sphyrna mokarran*		App II	App II	
	Smooth hammerhead *Sphyrna zygaena*			App II	

Table 1.3. (continued). Elasmobranch species listed by Multilateral Environmental Agreements.

Family	Species	Multinational Environmental Agreement			
		OSPAR	CMS	CITES	Bern
Pristidae	Sawfish *Pristidae*		App I and II	App I	
Rajidae	Common skate (*Dipturus batis*) complex	✓			
	Thornback ray *Raja clavata*	✓ North Sea			
	Spotted ray *Raja montagui*	✓ North Sea			
	White skate *Rostroraja alba*	✓			App III (Med)
Mobulidae	Reef manta ray *Manta alfredi*		App I and II		
	Giant manta ray *Manta birostris*		App I and II		
	Manta rays *Manta* spp.			App II	
	Longhorned mobula *Mobula eregoodootenkee*		App I and II	App II	
	Lesser devil ray *Mobula hypostoma*		App I and II	App II	
	Spinetail mobula *Mobula japanica*		App I and II	App II	
	Shortfin devil ray *Mobula kuhlii*		App I and II	App II	
	Giant devil ray *Mobula mobular*		App I and II	App II	App II (Med)
	Munk's (or pygmy) devil ray *Mobula munkiana*		App I and II	Ap II	
	Lesser Guinean devil ray *Mobula rochebrunei*		App I and II	App II	
	Chilean (or sicklefin) devil ray *Mobula tarapacana*		App I and II	App II	
	Smoothtail mobula *Mobula thurstoni*		App I and II	App II	

Table 1.4. Elasmobranch taxa listed as Prohibited Species on EU fisheries regulations. It is prohibited for EU vessels "*… to fish for, to retain on board, to tranship or to land …*" these species in certain areas within EU waters (Article 13) or, for certain species listed in Article 22, within the ICCAT Convention area. Adapted from CEC (2019; 2021).

Family	Species	Area
Centrophoridae	Leafscale gulper shark *Centrophorus squamosus*	EU waters of Division 2.a and subarea 4; EU and international waters of subareas 1 and 14
	Birdbeak dogfish *Deania calcea*	EU waters of Division 2.a and subarea 4; EU and international waters of subareas 1 and 14
Etmopteridae	Smooth lantern shark *Etmopterus pusillus*	EU waters of Division 2.a and subarea 4; EU and international waters of subareas 1, 5–8, 12 and 14
	Great lantern shark *Etmopterus princeps*	EU waters of Division 2.a and subarea 4; EU and international waters of subareas 1 and 14
Somniosidae	Portuguese dogfish *Centroscymnus coelolepis*	EU waters of Division 2.a and subarea 4; EU and international waters of subareas 1 and 14
Dalatiidae	Kitefin shark *Dalatias licha*	EU waters of Division 2.a and subarea 4; EU and international waters of subareas 1 and 14
Squatinidae	Angel shark *Squatina squatina*	EU waters
Alopiidae	Bigeye thresher shark *Alopias superciliosus*	ICCAT convention area
Cetorhinidae	Basking shark *Cetorhinus maximus*	All waters
Lamnidae	White shark *Carcharodon carcharias*	All waters
	Porbeagle shark *Lamna nasus*	All waters
Triakidae	Tope *Galeorhinus galeus*	When taken by longline in EU waters of Division 2.a and subarea 4, and EU and international waters of subareas 1, 5–8, 12 and 14.
Carcharhinidae	Silky shark *Carcharhinus falciformis*	ICCAT convention area
	Oceanic whitetip shark *Carcharhinus longimanus*	ICCAT convention area
	Hammerheads (Sphyrnidae), except for *Sphyrna tiburo*)	ICCAT convention area
Pristidae	Narrow sawfish *Anoxypristis cuspidata*	All waters
	Dwarf sawfish *Pristis clavata*	All waters
	Smalltooth sawfish *Pristis pectinata*	All waters
	Largetooth sawfish *Pristis pristis*	All waters
	Green sawfish *Pristis zijsron*	All waters
Rhinobatidae	All members of family	EU waters of subareas 1–12

Table 1.4. (continued). Elasmobranch taxa listed as Prohibited Species on EU fisheries regulations.

Family	Species	Area
Rajidae	Starry ray *Amblyraja radiata*	EU waters of Divisions 2.a, 3.a, 7.d and subarea 4
	Common skate (*Dipturus batis*) complex (*Dipturus cf. flossada and Dipturus cf. intermedia*)	EU waters of Division 2.a and subareas 3–4, 6–10.
	Norwegian skate *Dipturus nidarosiensis*	EU waters of subarea 6 and Divisions 7.a-c and 7e–h and 7.k
	Thornback ray *Raja clavata*	EU waters of Division 3.a
	Undulate ray *Raja undulata*	EU waters of subareas 6 and 10
	White skate *Rostroraja alba*	EU waters of subareas 6-10
Mobulidae	Reef manta ray *Manta alfredi*	All waters
	Giant manta ray *Manta birostris*	All waters
	Longhorned mobula *Mobula eregoodootenkee*	All waters
	Lesser (or Atlantic) devil ray *Mobula hypostoma*	All waters
	Spinetail mobula *Mobula japanica*	All waters
	Shortfin devil ray *Mobula kuhlii*	All waters
	Giant devil ray *Mobula mobular*	All waters
	Munk's (or pygmy) devil ray *Mobula munkiana*	All waters
	Lesser Guinean devil ray *Mobula rochebrunei*	All waters
	Chilean (or sicklefin) devil ray *Mobula tarapacana*	All waters
	Smoothtail mobula *Mobula thurstoni*	All waters

1.12 ICES fisheries advice

ICES advice is now provided under the Maximum Sustainable Yield framework (MSY).

Maximum sustainable yield is a broad conceptual objective aimed at achieving the highest possible yield over the long term (an infinitely long period of time). It is non-specific with respect to: (a) the biological unit to which it is applied; (b) the models used to provide scientific advice; and (c) the management methods used to achieve MSY.

The MSY concept can be applied to an entire ecosystem, an entire fish community, or a single fish stock. The choice of the biological unit to which the MSY concept is applied influences both the sustainable yield that can be achieved and the associated management options.

Implementation of the MSY concept by ICES will first be applied to individual fish stocks. Further information on the background to MSY and how it is applied to fish stocks by ICES can be found in the General Context to ICES Advice.

1.13 Data availability

General considerations

WGEF members agree that future meetings of WGEF should continue to meet in June, as opposed to meeting earlier in the year, as (a) more refined landings data are available; (b) meeting outside the main spring assessment period should provide national laboratories with more time to prepare for WGEF, (c) it will minimize potential clashes with other assessment groups (which could result in WGEF losing the expertise of stock assessment scientists) and (d) given that there are not major year-to-year changes in elasmobranch populations (cf. many teleost stocks), the advice provided would be valid for the following year.

The group agreed that survey data should be provided as disaggregated raw data, and not as compiled indices or data. The group agreed that those survey abundance estimates that are not currently in the DATRAS database are also provided as raw data by individual countries. It is recommended to have the data and code to calculate the survey indices to be made available on TAF (see other issues Section 27 in this report).

WGEF recommends that MS provide detailed explanations of how national data for species and length compositions are raised to total catch, especially when there may be various product weights reported (e.g. gutted or dressed carcasses and livers and/or fins).

ICES Data Call for landings data

Some of the data used in 2015 were submitted following the ICES Data Call. WGEF concluded that the format of the Data Call in that year, whereby some nations submitted individual files for each of the named stocks, was problematic, as it resulted in generic landings categories not being submitted by all nations and increased the workload of the group.

In 2016, the Data Call requested that nations submit a single file for all categories of elasmobranch in their national data for the period 2005–2015. The 2016 Data Call was viewed as successful and facilitated landings data (supplied by nearly all nations operating in the area of interest) to be supplied in a common format.

WGEF considered that the 2017 Data Call for landings data should be in the same format, but requesting only data for 2015 and 2016. It was also suggested that the 2017 Data Call request data earlier in the year (e.g. by the end of April), so that WGEF could undertake more data checks prior to the meeting. This format was followed in 2017, 2018 and 2019, but there were still considerable issues with data collation, formatting and QA that had to be addressed in the early stages of the meetings.

Since 2020, the data call requested nations to upload landings and discard data into InterCatch. The use of InterCatch facilitates data processing, improve transparency and allow members to conduct initial assessments prior to the meeting, removing a serious time-constraint.

Landings data

Landings data for years 2005 and later come from Data Calls (see above). WGEF uses some landings data extracted from ICES catch statistics, for time-series going back in time further than 2005. These data were mostly collated before 2005 although this task was hampered by the use by many countries of “nei” (not elsewhere identified) categories. Although strongly improving over time, for all years, the Working Group's best estimates are still considered inaccurate for a number of reasons:

i. Quota species may be reported as elasmobranchs to avoid exceeding quota, which would lead to over-reporting;
ii. Fishers may not take care when completing landings data records, for a variety of reasons;
iii. Administrations may not consider that it is important to collect accurate data for these species;
iv. Some species could be underreported to avoid highlighting that bycatch is a significant problem in some fisheries;
v. Some small inshore vessels may target (or have a bycatch of) certain species and the landings of such inshore vessels may not always be included in official statistics.

WGEF aims to arrive at an agreed set of data for each species and will document any changes to these datasets in the relevant working group report. A Workshop to compile and refine catch and landings of elasmobranchs (WKSHARK2) was held in January 2016 (ICES, 2016), and following this, the 2016 Data Call requested a standardised approach to data submission, including for a longer period. Up to 2019, the experts in collaboration with national data coordinators inspected the spreadsheet and amended the landings table manually. These amended data are considered to be more accurate than official statistics as regional laboratories and WGEF members can better provide information on local fisheries and interpretation of nominal records of various species (including errors in species coding).

During the 2019 meeting, continuing issues with how the Data Call is interpreted, the non-uniformity of the dataset and as well as the many issues with species coding and stock allocations were discussed at length. A dedicated group met with the ICES Data Centre prior to the 2020 Data Call to explore options to facilitate the process of rendering a by the group accepted landings table before the start of WGEF. The group developed a more automated process using InterCatch and an R-coding procedure available in the Transparent Assessment Framework (TAF). The procedure to obtain the landings data is described in the 2020 WGEF report (ICES, 2020c). The issue list, stock allocation file and R-code is available on github: https://github.com/ices-taf/WGEF_catches.

Discards data

The EU requires Member States to collect discard data on elasmobranchs. This discarding may include both regulatory discarding, when quota is limited, as well as the discarding of smaller and less marketable individuals. Whilst WGEF want to make progress from 'landings' to 'catch'-based advice, data from discard observer programmes has, to date, mostly been used in exploratory and descriptive analyses and, in a few cases only, for advice purpose.

EU countries have implemented national on-board observer programs to estimate discards of abundant commercially important species (e.g. hake, *Nephrops*, cod, sole, and plaice). The adopted sampling designs have been defined considering the métiers, seasons and areas relevant for those species. As a consequence, national sampling programmes might not be optimal for estimating precise and unbiased discards for elasmobranchs.

In 2017, ICES WKSHARK3 reviewed i) the suitability of national sampling programs to estimate elasmobranch discards (including rare species), ii) the discard information available and iii) the procedures/methods to calculate population level estimates of discards removals for different countries (UCES, 2017).

In 2020, discard data over the period 2009 to 2019 were collected and merged into a single spreadsheet in Excel This year, the 2020 discard data were added, making discard data from 2009 to

2020 available and easily accessible. However, it was noted that for many stocks the discard data were incomplete for most of the years. In addition, raising to national catch levels is uncertain and procedures are not standardized. Particularly problematic are the cases of species which are not landed, i.e. being either not commercial or being subject to conservation measures (e.g. zero TAC). For some stocks (rju.27.7de, rju.27.8ab, rjn.27.8c, rjn.27.9a and syc.27.8abd) discard data are deemed reliable and have been included in the advice.

Yet, the main issues concerning the estimation of elasmobranch total discards are:

1. Data quality

Species identification, in particular that for rare species or species rarely seen in a particular area/national fleet or metier is a problematic issue. There are also suspected errors on species identification in various national datasets.

2. Insufficient sampling effort

As, in each fishing haul or set, elasmobranchs constitute a small and highly variable fraction of the catch the uncertainty of the mean discards rate is intrinsically high. This uncertainty can only be addressed by a significant increase in the coverage of on-board observations.

As an example, IPMA updated the work presented at the WKSHARK3 (Figueiredo *et al.*, 2017 WD). A classical ratio estimator (deGraft-Johnson, 1969), under a two-phase sampling scheme, was used to estimate the annual total discarded weight of *Raja clavata*, (period 2011–2014) from commercial vessels operating at ICES Division 9.a (Portugal mainland), with LOA larger than 12 m and with fishing permit to set gillnets or trammel nets. Using the variances of the estimates obtained, the optimum sample sizes to subsample in each phase were determined by considering the two variables (number of hauls with nets and total number/weight of *R. clavata* discards) and on the strength of the ratio relationship between them. Under a fixed cost function and the minimum MSE of the mean ratio estimate, the optimal sample size for second phase of the sampling scheme (i.e. on-board observations) should be increased from 256 to 678 times in relation to the sampling size levels of the years analysed in order to reduced uncertainty in discard estimates.

3. Raising factor

The discard estimators used varied between countries (ICES, 2017). While some are based on the fraction of fishing effort to the total effort in the metier, others are based on the fraction of the landings of the focal species to the total landings of that species in the metier, or on the landings of all or a number of commercially important species to the total landings of those species. The discard estimator adopted by each country is dependent upon the sampling plan and characteristics of the particular country, fleet or metier. It is thus extremely unlikely that a one-for-all estimator can be adopted. Nevertheless, reliable discard estimates need to be available to WGEF, so minimum levels of estimate precision should be agreed.

Considering the example of French fisheries, it was possible to compare the estimated discards using two raising methods: the raising to the landings of the same species (referred to as standard method in Table 1.6) and the raising to the landings of all species. See WKSHARK3 for details of the latter method (ICES, 2017).

For some stocks, estimates are similar and consistent. In particular for the stock rjc.27.3a4d, which is caught mostly in Division 7.d by French fisheries, both methods suggest discards of about 100 t per year until 2014 and a recent increase. Similar estimates were also obtained for greater-spotted dogfish in the Celtic sea. However, for two stocks of lesser-spotted dogfish, a species where identification is not a problem and which is abundant in the areas considered and marketed in France, estimates are very different with higher estimates derived from the standard method. These estimated high levels seem unrealistic and require more investigation. It may be that lesser-spotted dogfish is 100% discarded in some fishing operations and retained at various levels depending on other factors, amongst which the catch of more valuable species. This effect might not apply to the greater-spotted dogfish, a larger more coastal species, caught predominately in small-scale fisheries.

Table 1.6. Discards estimates from different methods in French fisheries for one stock of thornback ray, two stocks of lesser spotted dogfish and three stocks of greater-spotted dogfish.

Stock	Method	2011	2012	2013	2014	2015	2016
rjc.27.347d	Standard	78	128	266	63	313	799
rjc.27.347d	All species	124	85	81	45	330	NA
syc.27.67	Standard*	3700	7372	3448	3770	4414	9600
	All species	2007	3527	2460	1728	2708	NA
syc.27.8abd	Standard	3342	4835	2497	4432	8616	8822
	All species	1182	1624	865	1266	2279	
	All species**	1371	1739	528	1255	2468	
syt.27.67	Standard	23	49	17	154	26	51
	All species	31	16	56	61	27	NA

*** Includes 7.d**

**** Métiers combined**

Discards estimates convey important information, for example estimates in the order of 1000 tonnes were obtained for the undulate ray in 7.de, compared to 20–70 tonnes per year of blonde ray in the western Channel. This broad comparison of the range of discards supports other evidence of much higher abundance of undulate ray compared to blonde ray in the English Channel.

4. Discard retention patterns

Discard-retention patterns change over time and between fleets and countries, and these changes can be associated with several different factors.

Biological communities are complex networks of species that change through time and space. Due to this, the spatial overlap between the target and secondary, or by-catch, species, caught by a certain fishery, is an important aspect that needs to be considered when estimating discards. In fact, as both target and non-target species are dynamic, the level of spatial overlap is likely to change with time even at small spatial scales.

Such spatial and temporal dynamics of fishing resources render estimates/predictions of catch and discard rates quite variable. This is exemplified by a Dutch (industry) study funded by the European Maritime and Fisheries Fund (2016–2018). In this study, vessels register and retain discards of quota regulated species by haul on-board. In the auction, the discards are sorted by species, measured and weighed. The results show that for the Dutch pulse fishery 80 to 90% of the rays are discarded. This high discard rate is mainly due to restrictive Dutch quota s for skates and rays.

In the case of elasmobranchs, some species may show highly seasonal variations in abundance or changes in local abundance. Single fishing vessels can show high variability in catch and discard rates between days of the week. Adding fishing fleet dynamics to the natural dynamics of target resources, the situation becomes even more complex and predictions of potential by-catch becomes even more uncertain. Given the restrictive quota for rays, Producer Organisations often take measures, e.g. setting a MLS limit the amount that can be landed per trip, to avoid an early exhaustion of the quota. Such measures may influence discard decisions in the fleet - especially in the context of the Landing Obligation. Difficulties in accounting for decision making process on board undermine the accuracy and quality of discard estimates. This situation requires the development of adequate estimators that take those aspects in consideration, under penalty of obtaining highly imprecise discard estimates which in turn, may have significant social and economic impacts on fishing communities.

Market demand and management measures are important drivers for elasmobranch discards. For example, WKSHARK3 estimated that the retention of smooth-hound probably increased over time in UK fisheries and the discarding of thornback ray in the Channel increased in recent years (ICES, 2017). These behaviours are probably a consequence of market opportunities for smooth-hound and limited TAC for thornback ray.

5. Discard survival

Owing to the apparent high survival of elasmobranchs after capture it is important to obtain separate estimates for dead and surviving discards. As a proportion of the discards would be alive, catch data (landings and estimated discards) do not equate with "dead removals" in terms of population dynamics. Understanding the survival rates of discarded individuals is therefore fundamental for informing potential exemptions from the EU landings obligation.

To date there have been only limited scientific studies on the discard survival of skates in European fisheries, and data on the immediate, short-term survival and longer-term discard survival of these species are lacking for most fisheries. A summary of those studies was compiled in WKSHARK3 (ICES, 2017). To inform discussions on the future EU landing obligation and to improve the quantification of dead discards, WGEF recommend the need to implement scientific studies to better assess and quantify the discard survival of the main commercial skates caught by the trawl fleets, especially otter trawlers operating in the Bay of Biscay and Iberian waters, beam trawl fleets operating in northern Europe and for gill- and trammel net fisheries used by the inshore polyvalent fleet.

6. Progress

In 2017 and 2019, workshops were held to address the issues surrounding the use of discards in the elasmobranch assessments (ICES, 2017; 2020). It was addressed again by WGEF at the 2019 meeting and decided that the issue is too complex to be solved during a workshop or working group meeting and will require a concerted effort to solve. WGEF recommends to initiate a collaborative project to address this issue and has formulated a recommendation for ICES to initiate a dialogue with DG Mare to explore the possibility of funding to support a project to address the serious issues surrounding the collection and registration of discard data, as well as how to include survivability, in order for the data to be used in future stock assessments.

Stock structure

This report presents the status and advice of various demersal, pelagic and deep-water elasmobranchs by individual stock component. The identification of stock structure has been based upon the best available knowledge to date (see the stock-specific sections for more details). However, it has to be emphasized that overall, the scientific basis underlying the identity of many of these stocks is currently weak. In most cases, stock identification is based on the distribution and relative abundance of the species, current knowledge of movements and migrations, reproductive mode, and consistency with management units.

WGEF considers that the stock definitions proposed in the report are limited for many species, and in some circumstances advice may refer to 'management units'.

WGEF recommends that increased research effort be devoted to clarifying the stock structure of the different demersal and deep-water elasmobranchs being investigated by ICES.

Length measurements

Further information on the issues of different types of length measurement can be found in earlier reports (see Section 1.15 of ICES, 2010b). WGEF recommends that length–frequency information both commercial and survey be made available to the group for those species for which length-based assessments could be considered.

Taxonomic problems

Incorrect species identifications or coding errors affect many relevant data sets, including commercial data and even some scientific survey data. WGEF consistently attempt to correct and report these errors when they are found. The FAO recently produced an updated guide to the chondrichthyan fish of the North Atlantic (Ebert and Stehmann, 2013).

1.14 Methods and software

Many elasmobranchs are data-limited, and the paucity of data can extend to:

- Landings data, which are often incomplete or aggregated;
- Life-history data, as most species are poorly known with respect to age, growth and reproduction;
- Commercial and scientific datasets that are compromised by inaccurate species identification (with some morphologically similar species having very different life-history parameters);
- Lack of fishery-independent surveys for some species (e.g. pelagic species) and the low and variable catch rates of demersal species in existing bottom-trawl surveys.

Hence, the work undertaken by WGEF often precludes the formal stock assessment process that is used for many commercial teleost stocks. The analysis of survey, biological and landings data are used in most cases to evaluate the status of elasmobranch species/stocks. This limitation may be eased by new data-poor assessment approaches, which have the potential to allow some ray stocks to be moved from assessment category 3 to category 2.

Analytical assessment models are only used in the stock assessments of two species; porbeagle and spurdog. In 2011, WGEF updated and refined the model last used for the spurdog assessment in 2008 and 2010. A benchmark assessment of spurdog was carried out prior to, and during WGEF 2011. Further information can be found in Section 2 of the 2011 WGEF report (ICES, 2011a). In 2017, WGEF used length-based indicators (LBI) and the Surplus Production in Continuous Time (SPiCT) to conduct exploratory assessments for three stocks (rjc.27.3a47d, rjn.27.3a4 and rjn.27.678abd).

In 2020, two new methods were presented. The first approach applied a Surplus Production Model in Continuous Time (SPicT, Pedersen and Berg, 2017) and a State Space Bayesian Model (SSBM). Landings data before 2009 were based on FAO data, no discards data were available for this period. Landings and discards data from 2009 to 2018 were obtained from in WGEF available landing and discard data. Cause of the disparity of discard data in time, multiple regression was applied to obtain an effort (time spent at sea) raising by fleet and species. For SSBM priors have been set for the initial biomass (Yinit) in 1990 (long run) and 2009 (short run), the intrinsic growth rate (r), the carrying capacity (K), the process error (σ), the observation error (τ) and the catchability (q). Model outputs from SSBM and SPicT tends to follow the same biomass trajectories. Initial biomass in 1990 has been estimated to be under 0.5 of the biomass at MSY for all species. The biomass is increasing for all of them, even if these stock rebuilding dynamics are not going at the same speed for all species. The second is the use of Close-Kin Mark Recapture (CKMR) method to estimate population size of thornback ray population in Subarea 8 (Bay of Biscay) and Subarea 4 and divisions 3.a and 7.d (Greater North Sea). CKMR is a new genetic technique, which allow establishing relationships among individuals in the absence of pedigree data and provides the basis for an estimation of the ray population by combining genomic kinship analysis with statistical modelling of population dynamics.

WGEF considers that there is scope in the future to move some of the category 3 skate and ray stocks into category 2 or 1. Further exploratory analysis will be undertaken and four stocks (por.27.nea, rjn.27.678abd, rjc.27.8 and rju.27.7de) will be benchmarked in 2022. In addition, WGEF made recommendations for a future benchmark of three North Sea ray in 2023.

For other species, WGEF followed the latest ICES guidelines on the assessment of data-limited stocks (ICES, 2012a).. In 2021, the group followed recommendations of WKSKATE which defined criteria for representativeness of surveys to be included in stock assessment, evaluated the suitability of different survey indicators and explored different methods of combining surveys (ICES, 2021). This implied that for some stocks (i.e. rjc.27.3a47d, sdv.27.nea and syc.27.3a47d) surveys were added to the assessment as these provide additional information on stock trends, while for spotted ray in Subarea 4 and divisions 3.a and 7.d (rjm.27.3a47d) the UK(E&W)–BTS–Q3 was excluded as it did not meet the agreed criteria for representativeness for this stock. For most species, survey data were available in DATRAS. However, some survey data, such as the BTS-BEL-Q3, are extracted by national institutes from their own national database because the full time series of the survey is not yet available in DATRAS. For certain low-abundance species, only landings information is available. For demersal elasmobranchs in the Celtic and North Sea, a 'survey status' is provided for each species. For Bay of Biscay and Iberia Coast, besides survey data for more frequently caught species, there is also fishery-dependent information. Survey data quickly illustrate the relative abundance of each species in each survey, as well as a visual indication of trends in abundance and mean length. Further details are outlined in each section.

1.15 InterCatch

In 2021, InterCatch was used to submit landings and discard data. InterCatch is solely used as a database to store official landings and discard data. Landings figures are supplied by individual members, after data formatting undertaken by WGEF (e.g. allocation to stock, quality assurance, reallocation of misidentified species). These corrected data are considered to be more accurate than official statistics as regional laboratories can better provide information on local fisheries and interpretation of nominal records of various species (including errors in species coding).

In 2021, landings data were requested in the InterCatch SI format and were requested to be submitted to InterCatch. However, not all nations have followed up on the data call and submitted the data to data.call@ices.dk. As such, part of the landings data were retrieved from the Accessions folder.

1.16 Transparent Assessment Framework (TAF)

TAF is a new framework, currently in development, to organize all ICES stock assessments. Using a standard sequence of R scripts, it makes the data, analysis, and results available online, and documents how the data were pre-processed. Among the key potential benefits of this structured and open approach are improved quality assurance and peer review of ICES stock assessments. Furthermore, a fully scripted TAF assessment is easy to update and rerun later with a new year of data. As of spring 2018, the first assessments are being scripted in standard TAF scripts (i.e. NE Atlantic spurdog (dgs.27.nea)). See http://taf.ices.dk for more information.

During the WGEF 2020 meeting, progress was made to have the processing of the InterCatch output being scripted in TAF. TAF includes the issues list and stock allocation file needed. The issues list will need to be updated on a yearly basis.

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2 Spurdog in the Northeast Atlantic

2.1 Stock distribution

Spurdog or the piked dogfish, *Squalus acanthias* has a worldwide distribution in temperate and boreal waters, and occurs mainly in depths of 10–200 m. In the NE Atlantic, this species is found from Iceland and the Barents Sea southwards to the coast of Northwest Africa (McEachran and Branstetter, 1984).

WGEF considers that there is a single NE Atlantic stock ranging from the Barents Sea (Subarea 1) to the Bay of Biscay (Subarea 8), and that this is the most appropriate unit for assessment and management within ICES. Spurdog in Subarea 9 may be part of the NE Atlantic stock, but catches from this area are likely to consist of a mixture of *Squalus* species, with increasing numbers of *Squalus blainville* further south.

Genetic microsatellite analyses conducted by Verissimo *et al.* (2010) found no differences between east and west Atlantic spurdog. The authors suggested this could be accomplished by transatlantic migrations of a very limited number of individuals. Further information on the stock structure and migratory pattern of Northeast Atlantic spurdog can be found in the Stock Annex. Nonetheless, recent studies undertaken by Thorburn *et al*. (2018) suggest subpopulations across the UK.

2.2 The fishery

2.2.1 History of the fishery

Spurdog has a long history of exploitation in the Northeast Atlantic (Pawson *et al*., 2009) and WGEF estimates of total landings are shown in Figure 2.1 and Table 2.1. Spurdog has historically been exploited by France, Ireland, Norway and the UK (Table 2.2). The main fishing grounds for the NE Atlantic stock of spurdog are the North Sea (Subarea 4), West of Scotland (Division 6.a) and the Celtic Seas (Subarea 7) and, during the decade spanning the late 1980s to 1990s, the Norwegian Sea (Subarea 2) (Table 2.3). Outside these areas, landings have generally been low. In recent years the fishery has changed significantly in line with restrictive management measures, which have included more restrictive quota, a maximum landing length and bycatch regulations.

Further details of the historical development of the fishery are provided in the Stock Annex. Further general information on the mixed fisheries exploiting this stock and changes in effort can be found in ICES (2009a, b) and STECF (2009).

2.2.2 The fishery in 2020

The zero TAC for spurdog for EU vessels, introduced in 2011, has resulted in a major change in the magnitude and spatial distribution of reported landings. Between 2005 and 2017, landings declined across all ICES subareas, slightly increasing in 2018, 2019 and 2020.

Since 2011 the annual Norwegian landings, which land significantly more spurdog than other countries, have been fluctuating between 217–370 tonnes. However, reported landings of spurdog from Norwegian fisheries were 409 tonnes in 2020.

In July 2016, an in-year amendment to EU quota regulations saw the introduction of a small TAC (270 t) for Union and international waters of subareas 1, 5–8, 10 and 12 (see Section 2.2.4). During

2018, 2019 and 2020, UK reported landings of 37, 52 and 79 tonnes spurdog, respectively. For UK, traditionally one of the major exploiters of the spurdog stock (prior to 2009), this was a major increase from a level close to zero that has been seen since the zero TAC was introduced in 2011. For other countries which landed spurdog, see Table 2.2.

Commercial fishermen in various areas, including the southern North Sea, the Celtic Sea, and in the south- and mid-Norwegian coastal areas, continue to report that spurdog can be seasonally abundant on their fishing grounds.

2.2.3 ICES advice applicable

In 2020, ICES advised that "*when the precautionary approach is applied, there should be no targeted fisheries on this stock in 2021 and 2022. Based on medium-term projections, annual catches at the recent assumed level (2468 tonnes) would allow the stock to increase at a rate close to that estimated with zero catches. Any possible provision for the landing of bycatch should be part of a management plan, including close monitoring of the stock and fisheries*".

2.2.4 Management applicable

The following table summarises ICES advice and actual management applicable for NE Atlantic spurdog during 2001–2020.

Year	Single-stock exploitation boundary (tonnes)	Basis	TAC (IIa(EC) and IV) (tonnes)	TAC IIIa , I, V, VI, VII, VIII, XII and XIV (EU and international waters) (tonnes)	TAC IIIa(EC) (tonnes)	TAC I, V, VI, VII, VIII, XII and XIV (EU and international waters) (tonnes)	WG landings (NE Atlantic stock) (tonnes)
2000	No advice	-	9470				15 890
2001	No advice	-	8870	-	-	-	16 693 (1)
2002	No advice	-	7100	-	-	-	11 020
2003	No advice	-	5640	-	-	-	12 246
2004	No advice	-	4472	-	-	-	9365
2005	No advice	-	1136	-	-	-	7100
2006	F=0	Stock depleted and in danger of collapse	1051	-	-	-	4015
2007	F=0	Stock depleted and in danger of collapse	841 (2)	2828	-	-	2917
2008	No new advice	No new advice	631 (2,3)	-	-	2004 (2)	1798
2009	F=0	Stock depleted and in danger of collapse	316 (3,4)	-	104 (4)	1002 (4)	1980
2010	F=0	Stock depleted and in danger of collapse	0 (5)		0 (5)	0 (5)	892
2011	F=0	Stock depleted and in danger of collapse	0 (6)		0	0 (6)	435

Year	Single-stock exploitation boundary (tonnes)	Basis	TAC (IIa(EC) and IV) (tonnes)	TAC IIIa , I, V, VI, VII, VIII, XII and XIV (EU and international waters) (tonnes)	TAC IIIa(EC) (tonnes)	TAC I, V, VI, VII, VIII, XII and XIV (EU and international waters) (tonnes)	WG landings (NE Atlantic stock) (tonnes)
2012	F=0	Stock below possible reference points	0 (6)		0	0 (6)	453
2013	F=0	Stock below possible reference points	0		0	0	335
2014	F=0	Stock below possible reference points	0		0	0	383
2015	F=0	Stock below possible reference points	0		0	0	263
2016	F=0	Stock below possible reference points	0		0	0 (270(7))	373
2017	F-0	Stock below possible reference points	0		0	270(7)	296
2018	F-0	Stock below possible reference points	0		0	270(7)	363
2019	F=0	Stock below possible reference points	0		0	270(7)	455
2020	F=0	Stock below possible reference points	0		0	270(7)	526

(1) The WG estimate of landings in 2001 may include some misreported deep-sea sharks or other species. (2) Bycatch quota. These species shall not comprise more than 5% by live weight of the catch retained on board. (3) For Norway: including catches taken with longlines of tope shark (*G. galeus*), kitefin shark (*D. licha*), bird beak dogfish (*D. calcea*), leafscale gulper shark (*C. squamosus*), greater lantern shark (*E. princeps*), smooth lanternshark (*E. spinax*) and Portuguese dogfish (*C. coelolepis*). This quota may only be taken in zones IV, VI and VII. (4) A maximum landing size of 100 cm (total length) shall be respected. (5)Bycatches are permitted up to 10% of the 2009 quotas established in Annex Ia to Regulation (EC) No. 43/2009 under the following conditions: catches taken with longlines of tope shark (*G. galeus*), kitefin shark (*D. licha*), bird beak dogfish (*D. calceus*), leafscale gulper shark (*C. squamosus*), greater lantern shark (*E. princeps*), smooth lantern shark (*E. pusillus*) and Portuguese dogfish (*C. coelolepis*) and spurdog (*S. acanthias*) are included (Does not apply to IIIa); a maximum landing size of 100 cm (total length) is respected; the bycatches comprise less than 10% of the total weight of marine organisms on board the fishing vessel. Catches not complying with these conditions or exceeding these quantities shall be promptly released to the extent practicable. (6) Catches taken with longlines of tope shark (*G. galeus*), kitefin shark (*D. licha*), bird beak dogfish (*D. calcea*), leafscale gulper shark (*C. squamosus*), greater lanternshark (*E. princeps*), smooth lanternshark (*E. pusillus*), Portuguese dogfish (*C. coelolepis*) and spurdog (*S acanthias*) are included. Catches of these species shall be promptly released unharmed to the extent practicable. (7) Spurdog shall not be targeted in the areas covered by this TAC. When accidentally caught in fisheries where spurdog is not subject to the landing obligation, specimens shall not be harmed and shall be released immediately, as required by Articles 12 (13 in 20180 and 41 (45 in 2018) of this Regulation. By derogation from Article 12 of this Regulation, a vessel engaged in the by-catch avoidance programme that has been positively assessed by the STECF may land not more than 2 tonnes per month of spurdog that is dead at the moment when the fishing gear is hauled on board. Member States participating in the by-catch avoidance programme shall ensure that the total annual landings of spurdog on the basis of this derogation do not exceed the above amounts. They shall communicate the list of participating vessels to the Commission before allowing any landings. Member States shall exchange information about avoidance areas.

In all EU regulated areas, a zero TAC for spurdog was retained for 2019. In July 2016, an in-year amendment to EU quota regulations (Council Regulation (EU) 2016/1252 of 28 July 2016) saw the introduction of a small TAC (270 t) for Union and international waters of subareas 1, 5–8, 10 and 12, with this TAC to be allocated to vessels participating in bycatch avoidance programmes. This regulation states that "*a vessel engaged in the by-catch avoidance programme that has been positively assessed by the STECF may land not more than 2 tonnes per month of picked dogfish that is dead at the moment when the fishing gear is hauled on board. Member States participating in the by-catch avoidance programme shall ensure that the total annual landings of picked dogfish on the basis of this derogation do not exceed the amounts indicated below. They shall communicate the list of participating vessels to the Commission before allowing any landings. Member States shall exchange information about avoidance areas*".

This derogation was not denoted for TAC areas for EU waters of 3.a or EU waters of 2.a and 4. In these areas, no EU landings were permitted.

In 2007, Norway introduced a general ban on target fisheries for spurdog in the Norwegian economic zone and in international waters of ICES subareas 1–14, with the exception of a limited fishery for small coastal vessels. Bycatch could be landed and sold as before. All directed fisheries were banned from 2011, although there is still a bycatch allowance. From October 2011, bycatch should not exceed 20% of total landings on a weekly basis. Since 4 June 2012, bycatch must not exceed 20% of total landings over the period 4 June–31 December 2012. From 1 January 2013, bycatch must not exceed 15% of total landings on a half calendar year basis. Live specimens can be released, whereas dead specimens must be landed. From 2011, the regulations also include recreational fisheries. Norway has a 70 cm minimum landing size (first introduced in 1964).

Since 1 January 2008, fishing for spurdog with nets and longlines in Swedish waters has been forbidden. In trawl fisheries, there is a minimum mesh size of 120 mm and the species may only be taken as a bycatch. In fisheries with hand-held gear only one spurdog was allowed to be caught and kept by the fisher during a 24-hour period.

Many of the mixed fisheries which caught spurdog in the North Sea, West of Scotland and Irish Sea are subject to effort restrictions under the cod long-term plan (EC 1342/2008).

2.3 Catch data

2.3.1 Landings

Total annual landings of NE Atlantic spurdog are given in Table 2.1 and illustrated in Figure 2.1. Preliminary estimates of landings for 2020 were 526 t.

2.3.2 Discards

Estimates of total amount of spurdog discarded are not routinely provided although some discard sampling does take place in several countries.

Data from Scottish observer trips in 2010 were made available to the WG. Over 1200 spurdog (raised to trip level and then summed across trips) were caught over 29 trips (across divisions 4.a and 6.a), but on no occasion were any retained.

At the 2010 WG, a working document was presented on the composition of Norwegian elasmobranch catches, which suggested significant numbers of spurdog were discarded.

Preliminary observations on the discard-retention patterns of spurdog as observed on UK (English) vessels were presented by Silva *et al.* (2013 WD; Figure 2.2).

No attempts to raise observed discard rates to fleet level have been undertaken as yet, and given the aggregating nature of spurdog, such analyses would need to be undertaken with care.

Further information on discards can be found in the Stock Annex.

2.3.3 Discard survival

Low mortality has been reported for spurdog caught by trawl when tow duration was < 1 h, with overall mortality of about 6% (Mandelman and Farrington, 2007; Rulifson, 2007), with higher levels of mortality (ca. 55%) reported for gillnet-caught spurdog (Rulifson, 2007).

Only limited data on at-vessel mortality are available for European waters (Bendall *et al.*, 2012), and there are no published data on post-release mortality.

2.3.4 Quality of the catch data

In addition to the problems associated with obtaining estimates of the historical total landings of spurdog, due to the use of generic dogfish landings categories, anecdotal information suggests that widespread misreporting by species may have contributed significantly to the uncertainties in the overall level of spurdog landings.

Underreporting may have occurred in certain ICES areas when vessels were trying to build up a track record of other species, for example deep-water species. It has also been suggested that over-reporting may have occurred in the case where other elasmobranch stocks with highly restrictive quotas have been recorded as spurdog. It is not possible to quantify the amount of under and over-reporting that may have occurred. The introduction of UK and Irish legislation requiring registration of all fish buyers and sellers should mean that such misreporting problems have declined since 2006.

It is not known whether the 5% bycatch ratio (implemented in 2008) or the maximum landing length (in 2009) led to misreporting (although the buyers and sellers legislation should deter this) or increased discarding.

Given the zero TAC in place, recent catch data are highly uncertain. Whilst data from discard observer programmes may allow catches to be estimated, the estimation of dead discards will be more problematic.

Some nations may now be reporting landings of spurdog under more generic codes (e.g. *Squalus* sp., Squalidae and Squaliformes) as well as for *Squalus acanthias*.

2.4 Commercial catch composition

2.4.1 Length composition of landings

Sex disaggregated length–frequency samples are available from UK (E&W) for the years 1983–2001 and UK (Scotland) for 1991–2004 for all gears combined. The Scottish length–frequency distributions appear to be quite different from the length–frequency distributions obtained from the UK (E&W) landings, with a much larger proportion of small females being landed by the Scottish fleets. Figure 2.2 shows landings length–frequency distributions averaged over five-year intervals. The Scottish data have been raised to total Scottish reported landings of spurdog while the UK (E&W) data have only been raised to the landings from the sampled boats, a procedure which is likely to mean that the latter length frequencies are not representative of total removals by the UK (E&W) fleet. For this reason, the UK (E&W) length frequencies are assumed to be representative only of the landings by the target fleet from this country.

Raw market sampling data were also provided by Scotland for the years 2005–2010. However, sampled numbers have been low in recent years (due to low landings) and use of these data was not pursued.

2.4.2 Length composition of discards

Discard length–frequency data were provided by the UK (Scotland) for 2010. Length frequencies raised to trip level and pooled over all trips and areas by gear type are shown in Figure 2.3. These have not been raised to fleet level.

Discard length–frequency data were provided by the UK (England) for four broad gear types (Figure 2.4). In general, beam trawlers caught relatively few spurdog, and these were comprised mostly of juveniles, gillnets catches were dominated by fish 60–90 cm TL and otter trawlers captured a broad length range. Data for larger fish sampled across the whole time-series were most extensive for gillnetters operating in the Celtic Seas (Silva *et al.,* 2013 WD). The discarding rates of commercial sized fish (80–100 cm TL) from these vessels increased from 7.5% (2002–2008) to 18.7% (2009–2010), whereas the proportion of fish > 100 cm LT discarded increased from 6.2% (2002–2008) to 34.1% (2009–2010), indicating an increased proportion of larger fish were discarded in line with the maximum landing length regulations that were in force during 2009–2010. The zero TAC with no bycatch allowance resulted in the discarding of all observed spurdog in 2011.

2.4.3 Sex ratio

No recent data.

2.4.4 Quality of data

Length–frequency samples were only available for UK landings and these were aggregated into broader length categories for the purpose of assessment. No data were available from Norway or Ireland, which were the other main nations exploiting this stock. For the 20 years prior to restrictive measures, UK landings accounted for approximately 45% of the total. However, there has been a systematic decline in this proportion since 2005 and the UK landings in 2008 represented 15% of the total. In 2010, UK landings were just above 5% of the total, and < 1% in 2011. It is not known to what extent the available commercial length–frequency samples are representative of the catches by these other nations. In addition, there are only limited length–frequency data from recent years.

From French on-board observation data, the occurrence of spurdog was calculated as the proportion of fishing operations (trawl haul or net set) with catch (discards, landings or both) of spurdog in areas where the species is observed regularly in French fisheries, namely Subarea 6 and divisions 7.b-c and 7.f-k from 2007–2015. Other areas, such as the Bay of Biscay (Subarea 8) where occurrences are rare in French Fisheries were excluded. Fishing operations were aggregated by DCF level 5 métier. The time-series of the proportion of fishing operations encountering spurdog is shown for the four top ranking métiers (Figure 2.36). No trend was observed in the two main métiers (OTB-DEF and OTT-DEF), with the two other métiers (with lower numbers of observed fishing operations) showing contrasting signals.

2.5 Commercial catch-effort data

No commercial CPUE data were available to the WG.

The outline of a Norwegian sentinel fishery on spurdog was presented to the 2012 WG (Albert and Vollen, 2012 WD). This potential provider of an abundance index series has not been initiated yet.

A UK Fishery Science Partnership (FSP) study carried out by CEFAS examined spurdog in the Irish Sea (Ellis *et al*., 2010), primarily to (a) evaluate the role of spurdog in longline fisheries and examine the catch rates and sizes of fish taken in a longline fishery; (b) provide biological samples so that more recent data on the length-at-maturity and fecundity can be calculated; and (c) tag and release a number of individuals to inform on the potential discard survivorship from longline fisheries. Survey stations were chosen by the fishermen participating in the survey.

This survey undertook studies on a commercial, inshore vessel that had traditionally longlined for spurdog during parts of the year. Four trips (nominally one in each quarter), each of four days, were undertaken over the course of the year. The spurdog caught were generally in good condition, although the bait stripper can damage the jaws, and those fish tagged and released were considered to be in a good state of health.

Large numbers of spurdog were caught during the first sampling trip, of which 217 were tagged with Petersen discs and released. The second sampling trip yielded few spurdog, although catches at that time of year are considered by fishermen to be sporadic. Spurdog were not observed on the first three days of the third trip, but reasonable numbers were captured on the last day, just off the Mull of Galloway. The fourth trip (spread over late October to early December, due to poor weather) yielded some reasonably large catches of spurdog from the grounds just off Anglesey.

2.6 Fishery-independent information

2.6.1 Availability of survey data

Fishery-independent survey data are available for most regions within the stock area. Beam trawl surveys are not considered appropriate for this species, due to the low catchability of spurdog in this gear type. The surveys coordinated by IBTS have higher catchability and the gears are considered suitable for this species. Spatial coverage of the North and Celtic Seas represents a large part of the stock range (Figure 2.5). For further details of these surveys and gears used see ICES (2010). The following survey data have been used in earlier analyses by WGEF:

- UK (England & Wales) Q1 Celtic Sea groundfish survey: years 1982–2002.
- UK (England & Wales) Q4 Celtic Sea groundfish survey: years 1983–1988.
- UK (England & Wales) Q3 North Sea groundfish survey 1977–present.
- UK (England & Wales) Q4 SWIBTS survey 2004–2009 in the Irish and Celtic Seas.
- UK (NI) Q1 Irish Sea groundfish survey 1992–2008.
- UK (NI) Q4 Irish Sea groundfish survey 1992–2008.
- Scottish Q1 west coast groundfish survey: years 1990–2010 (ScoGFS-WIBTS-Q1) and 2011–2015 (UKSGFS-WIBTS-Q1).
- Scottish Q4 west coast groundfish survey: years 1990–2009 (ScoGFS-WIBTS-Q4) and 2011–2015 (UKSGFS-WIBTS-Q4).
- Scottish Q1 North Sea groundfish survey: years 1990–2010.
- Scottish Q3 North Sea groundfish survey: years 1990–2009.
- Scottish Rockall haddock survey: years 1990–2009.
- Irish Q3 Celtic Seas groundfish survey: years 2003–2009.
- North Sea IBTS (NS-IBTS) survey: years 1977–2010.

A full description of the current groundfish surveys can be found in the Stock Annex.

Norwegian data on spurdog from the Shrimp survey (NO-shrimp-Q1) and the Coastal survey (NOcoast-Aco-Q4) were presented to the WGEF in 2014 and 2018 (Vollen, 2014 WD). The survey coverage is shown in Figure 2.6, and general information on the surveys can be found in Table 2.4.

The annual shrimp survey (1998–2020) covers the Skagerrak and the northern parts of the North Sea north to 60°N. The timing of the survey changed from quarter 4 (1984–2003), via quarter 3 (2002–2004), to quarter 1 from 2005. Mesh size was not specified for the first years, 35 mm from 1989–1997, and 20 mm from 1998. Trawl time was one hour from 1984–1989, then 30 minutes for later years.

The coastal survey (1996–2020) yearly covers the areas from 62°N to the Russian border in the north in October–November. Only data south of 66°N were used, as very few spurdog were caught north of this latitude. Length data were available from 1999 onwards. A Campelen Shrimp trawl with 40 mm mesh size was used from 1995–1998, whereas mesh size was 20 mm for later years. Trawl time was 20–30 minutes.

Spurdog catches in these surveys are not numerous. Number of stations with spurdog catches ranged from one to 35 per year in the shrimp survey; and from 0 to 8 per year in the coastal survey. The total number of spurdog caught ranged from one to 341 individuals per year in the shrimp survey, and from 0 to 106 individuals per year in the coastal survey (Table 2.4).

2.6.2 Length–frequency distributions

Length–frequency distributions (aggregated overall years) from the UK (E&W), Scottish and Irish groundfish surveys are shown in Figures 2.7–2.8.

The UK (E&W) groundfish survey length–frequency distribution (Figure 2.7a) consists of a high proportion of large females, although this is influenced by a single large catch of these individuals. Mature males are also taken regularly and juveniles often caught on the grounds in the northwestern Irish Sea.

The Irish Q4 GFS also catches some large females (Figure 2.7b), but the majority of individuals (both males and females) are of intermediate size, in the range 50–80 cm.

The Scottish West coast groundfish surveys demonstrate an almost complete absence of large females in their catches (Figure 2.8). These surveys show a high proportion of large males and also a much higher proportion of small individuals, particularly in the Q1 survey. However, it should be noted that length frequency distributions exhibit high variability from year to year (not shown) with a small number of extremely large hauls dominating the length–frequency data.

In the UK FSP survey, the length range of spurdog caught was 49–116 cm (Figure 2.9), with catches in Q1 and Q3 being mainly large (> 90 cm) females. Catches in Q4 yielded a greater proportion of smaller fish. The sex ratio of fish caught was heavily skewed towards females, with more than 99% of the spurdog caught in Q1 female. Although more males were found in Q3 and Q4, females were still dominant, accounting for 87% and 79% of the spurdog catch, respectively. Numerically, between 16.5 and 41.9% of spurdog captured were > 100 cm, the Maximum Landing Length in force at the time.

In the Norwegian Shrimp and Coastal surveys, the length–frequency distribution was rather uniform overall years, with the length groups 60–85 cm being the most abundant (Figure 2.10).

Previously presented length frequencies are displayed in the Stock Annex.

2.6.3 CPUE

Spurdog survey data are typically characterised by highly variable catch rates due to occasional large hauls and a significant proportion of zero catches.

Time-series plots of frequency of occurrence (proportion of non-zero hauls) for the Irish surveys are shown in Figure 2.12. This short time-series shows stability on the frequency of occurrence and on the catch rates. For UK surveys, previously presented data (either discontinued or not updated this year) have indicated a trend of decreasing occurrence and decreasing frequency of large catches with catch rates also decreasing (although highly variable) (Figures 2.16–2.17).

Time-series plots of frequency of occurrence (five year running mean) for both Norwegian surveys is shown for > 20 years in Figure 2.13; shrimp survey (1985–2018) and coastal survey (1995–2018). The frequency of occurrence declined for the Shrimp survey from late 1980s and reached a low in late 1990s. Since then, the Shrimp survey shows an increasing trend, whereas the Coastal survey shows a decreasing trend. With regards to average catch range, numbers are variable, but a decrease can be seen from the 1980s to the late 1990s for the Shrimp survey. For the Coastal survey, a peak could be seen around 2004, but it should be noted that results are generally based on very few stations.

Future studies of survey data could usefully examine surveys from other parts of the stock area, as well as sex-specific and juvenile abundance trends. In the absence of accurate catch data, fishery-independent trawl surveys will be increasingly important to monitor stock recovery.

2.6.4 Statistical modelling

At the 2006 WG meeting, an analysis of Scottish survey data was presented, which investigated methods for standardizing the survey catch rate with the aim obtaining an appropriate index of abundance. Following on from this, and the subsequent comments of the Review Group, further analysis was conducted in 2009 to provide an index of biomass catch rates rather than abundance in N.hr-1. As at previous WG meetings a biomass index was derived from an analysis of Scottish survey data.

Data from four Scottish surveys listed above (1990–2019) were considered in the analysis (Rockall was not included due to the very low numbers of individuals caught in this survey). The dataset consists of length–frequency distributions at each trawl station (almost 8000 in total), together with the associated information on gear type, haul time, depth, duration and location. For each haul station, catch-rate was calculated: total weight caught (derived from length using the length-weight relationship) divided by the haul duration to obtain a measure of catch-per-unit of effort in terms of g/30 minutes.

The objective of the analysis was to obtain standardized annual indices of CPUE (on which an index of relative abundance can be based) by identifying explanatory variables which help to explain the variation in catch rate and which is not a consequence of changes in population size. Due to the highly skewed distribution of catch rates and the presence of the large number of zeros, a 'delta' distribution approach was taken to the statistical modelling. Lo *et al.*, 1992 and Stefansson, 1996 describe this method which combines two generalized linear models (GLM): one which models the probability of a positive observation (binomial model) and the second which models the catch rate conditioned on it being positive assuming a lognormal distribution. The overall year effect (annual index) can then be calculated by multiplying the year effects estimated by the two models.

The aim of the analysis was to obtain an index of temporal changes in CPUE and therefore year was always included as a covariate (factor) in the model. Other explanatory variables included were area (Scottish demersal sampling area, see Dobby et al. (2005) for further details) and month or quarter. Variables which explained greater than 5% of the deviance in previous analysis were retained in the model. All variables were included as categorical variables.

The model results, in terms of retained terms and deviance values are presented in Table 2.5. Estimated effects are shown in Figure 2.18. The diagnostic plot for the final lognormal model fit is shown in Figure 2.19, indicating that the distributional assumptions are adequate: the residuals show a relatively symmetrical distribution, with no obvious departures from normality, and the residual variance shows no significant changes through the range of fitted values.

The estimated year effects for the binomial component of the model demonstrate a significant decline over the overall first part of the time period with an increase in more recent years. The year effects for the catch rate given that it is positive show a generally increasing trend since around 2006. Although this index is used within the assessment, there are a number of issues associated with the analysis which should be highlighted:

- The survey data analysed only covers a proportion of the stock distribution (Division 6.a and the northern North Sea);
- The two Scottish west coast surveys underwent a redesign in 2011, including the use of new ground-gear. No consideration has been given to potential changes in catchability due to the new ground-gear in this analysis.
- A sex-disaggregated index would potentially be more informative.

The upcoming benchmark represents an opportunity to explore additional survey data and alternative approaches to modelling data containing a high proportion of zeros.

2.7 Life-history information

Maturity and fecundity data were collected on the UK FSP surveys (Ellis et al, 2010). The largest immature female spurdog was 84 cm, with the smallest mature female 78 cm. The smallest mature and active female observed was 82 cm. All females ≥ 90 cm were mature and active. The observed uterine fecundity was 2–16 pups, and larger females produced more pups. In Q1, the embryos were either in the length range 11–12 cm or 14–18 cm, and no females exhibited signs of recently having given birth. In Q3, near-term pups were observed at lengths of 16–21 cm. During Q4, near-term and term pups of 19–24 cm were observed, and several females showed signs of recently having pupped. This further suggests that the Irish Sea may be an important region in which spurdog give birth during late autumn and early winter, although it is unclear if there are particular sites in the area that are important for pupping.

Collection of biological data for *S. acanthias* was possible as part of a Defra-funded project aiming to better understand the implications of elasmobranch bycatch in the southwest fisheries around the British Isles (Silva and Ellis, 2015 WD). A total of 1112 specimens were examined, including 805 males (53–92 cm LT) and 307 females (47–122 cm LT), as well as associated pups (n = 935, 98–296 mm LT). Conversion factors were calculated for the overall relationships between total length and total weight by sex and maturity stage and gutted weight by sex only.

Preliminary results suggested there may be no changes of length-at-maturity of females in comparison to earlier estimates of Holden and Meadows (1962), indicating that this life-history parameter may not have changed in relation to recent overexploitation. However, the maximum fecundity observed (n = 19 pups) reported in this recent study is higher than reported in earlier studies (e.g. Ford, 1921; Holden and Meadows, 1964; Gauld, 1979), and provides further support to the hypothesis that there has been a density-dependent increase in fecundity (see Ellis and Keable, 2008 and references therein).

Updated life history data have also been collected (Albert *et al*., 2019; see Section 2.14), which should be investigated for any update to the benchmark assessment.

The biological parameters currently used in the assessment can be found in the Stock Annex.

2.8 Exploratory assessments and previous analyses

2.8.1 Previous assessments

Exploratory assessments undertaken in 2006 included the use of a delta-lognormal GLM-standardized index of abundance and a population dynamic model. This has been updated at subsequent meetings. The results from these assessments indicate that spurdog abundance has declined, and that the decline is driven by high exploitation levels in the past, coupled with biological characteristics that make this species particularly vulnerable to such intense exploitation (ICES, 2006).

2.8.2 Simulation of effects of maximum landing length regulations

Earlier demographic studies on elasmobranchs indicate that low fishing mortality on mature females may be beneficial to population growth rates (Cortés, 1999; Simpfendorfer, 1999). Hence, measures that afford protection to mature females may be an important element of a management plan for the species. As with many elasmobranchs, female spurdog attain a larger size than males, and larger females are more fecund.

Preliminary simulation studies of various Maximum Landing Length (MLL) scenarios were undertaken by ICES (2006) and suggested that there are strong potential benefits to the stock by protecting mature females. However, improved estimates of discard survivorship from various commercial gears are required to better examine the efficacy of such measures.

2.9 Stock assessment

2.9.1 Introduction

A benchmark assessment of the model was carried out in 2011. A summary of review comments and response to it were provided in Appendix 2a of the 2011 WGEF report (ICES, 2011), and is reproduced in an Appendix to the Stock Annex. The model is described in detail in the Stock Annex, and in De Oliveira *et al*. (2013).

In 2011, WGEF updated the model based on the benchmark assessment. Subsequent update assessments were carried out in 2014, 2016 and 2018, and the results presented here are for a further update to include data up to 2019.

The 2018 ADGEF expressed their concern about the constant catch assumption after the moratorium (2010+). This concern was discussed during the 2020 WGEF whereby the group decided to present two assessments reflecting alternative assumptions about the catch in the moratorium period to the 2020 ADGEF (ICES, 2020). One assessment reflects the constant catch scenario set at the average landings for 2007–2009 (C_{SQ})and a second assessment assumes a constant harvest rate set at the average harvest rate for 2007–2009 (HR_{SQ}), which is considered to be a more realistic approach. The 2020 ADGEF decided to go with the same approach as used in previous assessments, i.e. the constant catch scenario approach because this was viewed as the most accurate information on catch, as most of it is bycatch. In addition, no change in the basis of the advice was preferred as the stock would be due for a full benchmark in 2021.

Life-history parameters and input data

Calculation of the life-history parameters M_a (instantaneous natural mortality rate), l_a^s (mean length-at-age for animals of sex *s*), w_a^s (mean weight-at-age for animals of sex *s*), and P_a'' (proportion females of age *a* that become pregnant each year) are summarised in Table 2.6, and described visually in Figure 2.20.

Landings data used in the assessment are given in Tables 2.7a and b. Two assessments have been prepared, one with a constant catch assumption for 2010+ (as assumed in previous years) and one assuming the harvest rate has been constant since 2010 (which is likely to be a more realistic assumption); the difference in catches between these two scenarios are shown in Table 2.7b. The assessment requires the definition of fleets with corresponding exploitation patterns, and the only information currently available to provide this comes from Scottish and English & Wales databases. Two fleets, a "non-target" fleet (Scottish data) and a "target" fleet (England & Wales data), were therefore defined and allocated to landings data. Several targeting scenarios were explored in order to show the sensitivity of model results to these allocations (ICES, 2011), and these results are included here. In order to take the model back to a virgin state, the average proportion of these fleets for 1980–1984 were used to split landings data prior to 1980, but two of the targeting scenarios assume historic landings were only from "non-target" or "target" fleets.

The Scottish survey abundance index (biomass catch rate) was derived on the basis of applying a delta-lognormal GLM model to four Scottish surveys over the period 1990–2019, and is given in Table 2.8 along with the corresponding CVs. The proportions-by-length category data derived from these surveys, along with the actual sample sizes these data are based on, are given in Table 2.9 separately for females and males.

Table 2.10 lists the proportion-by-length-category data for the two commercial fleets considered in the assessment, along with the raised sample sizes. Because these raised sample sizes do not necessarily reflect the actual sample sizes the data are based on (as they have been raised to landings), these sample sizes have been ignored in the assessment (by setting $n_{pcom,j,y} = \bar{n}_{pcom,j}$ in equation 10b of the Stock Annex); a sensitivity test conducted in ICES (2010) showed a lack of sensitivity to this assumption.

The fecundity data (see Ellis and Keable, 2008, for sampling details) are given as pairs of values reflecting length of pregnant female and corresponding number of pups, and are listed in tables 2.11a and b for the two periods (1960 and 2005).

2.9.2 Summary of model runs in WGEF 2020

Category	Description	Figures	Tables
Base case run	Results presented for two assessments, differing by the assumption made about catches for 2010+: C_{SQ} assumes constant catches at the average landings for 2007-2009 HR_{SQ} assumes constant harvest rate at the average harvest rate for 2007-2009 All results (apart from Figure 2.30) are reported for these two assessments	2.21–27, 2.31–33	2.12–15
Retrospective	A 6-year retrospective analysis, using the base case run and omitting one year of data each time	2.28	
Sensitivity			
Q_{fec}	A comparison with an alternative Q_{fec} values that fall within the 95% probability interval of Figure 2.21, with a demonstration of the deterioration in model fit to the survey abundance index for higher Q_{fec} values	2.22, 2.29	
Targeting scenarios	A comparison of alternative assumptions about targeting (taken from ICES, 2011): Tar 1: the base case (each nation is defined “non-target”, “target” or a mixture of these, with pre-1980s allocated the average for 1980–1984) Tar 2: as for WGEF in 2010 (Scottish landings are “non-target”, E&W “target”, and the remainder raised in proportion to the Scottish/E&W landings, with pre-1980s allocated the average for 1980–1984) Tar 3: as for Tar 2 but with E&W split 50% “non-target” and 50% “target” Tar 4: as for Tar 1, but with pre-1980 selection entirely non-target Tar 5: as for Tar 1, but with pre-1980 selection entirely target	2.30	

2.9.3 Results for base case run

Model fits

Two assessments have been prepared, one with a constant catch assumption for 2010+ (as assumed in previous years; taken as the average catch 2007-9) and one assuming the harvest rate has been constant since 2010 (average harvest rate 2007–9, which is likely to be a more realistic assumption). Therefore, all plots and tables reflect these two assessments, and they are distinguished in figure and table captions by the labels “C_{SQ}” (constant catch assumption for 2010+) and “HR_{SQ}” (constant harvest rate assumption for 2010+).

Fecundity data available for two periods present an opportunity to estimate the extent of density-dependence in pup-production (Q_{fec}). However, estimating this parameter along with the fecundity parameters a_{fec} and b_{fec} for the two time-periods was not possible because these parameters are confounded. The approach therefore was to plot the likelihood surface for a range of fixed a_{fec} and b_{fec} input values, while estimating Q_{fec}, and the results are shown in Figure 2.21. The two periods of fecundity data are essential for the estimation of Q_{fec}, and further information that would help with the estimation of this parameter would be useful. Figure 2.21d indicates a near-linear relationship between Q_{fec} and $MSYR$ (defined in terms of the biomass of all animals $\geq l^{f}_{mat00}$), so additional information about $MSYR$ levels typical for this species could be used for this purpose (but has not yet been attempted).

The value of Q_{fec} chosen for the base case run (2.149 for both C_{SQ} and HR_{SQ} assessments) corresponded to the lower bound of the 95% probability interval shown in Figures 2.21a and b. Lower Q_{fec} values correspond to lower productivity, so this lower bound is more conservative than other values in the probability interval. Furthermore, sensitivity tests in the past had shown that higher Q_{fec} values were associated with a deterioration in the model fit to the Scottish survey abundance index, but this appears no longer to be the case (Figure 2.22), and will be investigated at the forthcoming benchmark meeting.

Figures 2.22a and b show the model fit to the Scottish surveys abundance index for the base case value of Q_{fec} and for alternative values that still fall within the 95% confidence interval in plot c of Figures 2.21a and b. Figures 2.23a and c show the model fit to the Scottish and England & Wales commercial proportion-by-length-category data, and Figures 2.23b and d the model fit to the Scottish survey proportion-by-length-category data, the latter fitted separately for females and males. Model fits to the survey index and commercial proportion data appear to be reasonably good with no obvious residual patterns, and a close fit to the average proportion-by-length-category for the commercial fleets. Figures 2.23b and d indicate a poorer fit to the survey of sex proportions compared to the commercial proportions, but given the residual patterns (a dominance of positive residuals for females, and, more weakly, the opposite for males) it may be possible to estimate sex ratio (to be investigated during the forthcoming benchmark).

Figures 2.24a and b compare the deterministic and stochastic modelled recruitment, and plot the estimated normalised recruitment residuals. The model fits of the two periods of fecundity data are shown in Figures 2.25a and b, highlighting the difference in the fecundity relationship with female length for the two periods (1960 and 2005), this difference being due to Q_{fec}.

Estimated parameters

Model estimates of the total number of pregnant females in the virgin population ($N_0^{f,preg}$), the extent of density-dependence in pup production (Q_{fec}), survey catchability (q_{sur}), and current (2020) total biomass levels relative to 1905 and 1955 (B_{depl05} and B_{depl55}), are shown in Tables 2.12a and c (for the "base case" and alternative Q_{fec} values) together with estimates of precision. Estimates of the natural mortality parameter M_{pup}, the fecundity parameters a_{fec} and b_{fec}, and MSY parameters ($F_{prop,MSY}$, MSY, B_{MSY}, MSY $B_{trigger}$ and $MSYR$) are given in Tables 2.12b and d. Tables 2.13a and b provide a correlation matrix for some of the key estimable parameters (only the last five years of recruitment deviations are shown). Correlations between estimable parameters are generally low, apart from the commercial selectivity parameters associated with length categories 55–69 cm and 70–84 cm, and Q_{fec} vs. q_{sur}.

Estimated commercial- and selectivity-at-age patterns are shown in Figures 2.26a and b, and reflect the relatively lower proportion of large animals in the survey data when compared to the commercial catch data, and the higher proportion of smaller animals in the Scottish commercial catch data compared to England & Wales (see also Figures 2.23a-d). It should be noted that females grow to larger lengths than males, so that females are able to grow out of the second highest length category, whereas males, with an L_∞ of < 85 cm (Table 2.6) are not able to do so (hence the commercial selectivity remains unchanged for the two largest length categories for males). The divergence of survey selectivity for females compared to males is a reflection of the separate selectivity parameters for females/males in the largest length category (70+ for surveys).

A plot of recruitment vs. the number of pregnant females in the population, effectively a stock–recruit plot, is given in plot b of Figures 2.24a and b together with the replacement line (the number of recruiting pups needed to replace the pregnant female population under no harvesting). This plot illustrates the importance of the Q_{fec} parameter in the model: a Q_{fec} parameter equal to 1 would imply the expected value of the stock–recruit point lies on the replacement line, which implies that the population is effectively incapable of replacing itself. A further exploration of the behaviour of Q_y and $N_{pup,y}$ (equations 2a and b in the Stock Annex) is shown in Figures 2.27a and b.

Time-series trends

Model estimates of total biomass (By) and mean fishing proportion (Fprop5-30,y) are shown in Figures 2.32a and b together with observed annual catch ($C_y = \sum_j C_{j,y}$). They indicate a strong decline in spurdog total biomass, particularly since the 1940s, to a low around the mid-2000s (19% of pre-exploitation levels), which appears to be driven by relatively high exploitation levels, given the biological characteristics of spurdog. $F_{prop5\text{-}30,y}$ appears to have declined in recent years, with B_y increasing again to 27% of pre-exploitation levels in 2020 (Bdepl05 in Tables 2.12a and c). Figures 2.32a and b also show total biomass (B_y), recruitment (R_y) and mean fishing proportion ($F_{prop5\text{-}30,y}$) together with approximate 95% probability intervals. The fluctuations in recruitment towards the end of the time-series are driven by information in the proportion-by-length-category data. Tables 2.14a and b provide a stock summary (recruitment, total biomass, landings and $F_{prop5\text{-}30,y}$).

2.9.4 Retrospective analysis

A six year retrospective analysis (the base case model was re-run, each time omitting a further year in the data) was performed, and is shown in Figures 2.28a and b for the total biomass (B_y), mean fishing proportion ($F_{prop5\text{-}30,y}$) and recruitment (R_y). A retrospective pattern appears to have developed since the 2016 assessment (see ICES, 2016). Although a worrying development (to be investigated at the forthcoming benchmark), the retrospective patterns are still well within the 95% confidence limits of the assessments estimates (compare Figures 2.28a and b with Figure 2.32a and b, respectively), Mohn's rho metrics are all less than 0.2 in absolute terms (these metrics are given in the plots of Figures 2.28a and b), and the retrospective pattern is in the conservative direction (underestimating stock size and overestimating fishing pressure), so not an immediate concern.

2.9.5 Sensitivity analyses

Two sets of sensitivity analyses were carried out, as listed in the text table above.

a) Q_{fec}

The a_{fec} and b_{fec} values that provided the lower bound of the 95% probability interval (Q_{fec}=2.149; plots a-c in Figures 2.21a and b) was selected for the base case run. This sensitivity test compares it to the runs for which the a_{fec} and b_{fec} input values provide the optimum (C_{SQ}: Q_{fec}=2.629) and upper bound (C_{SQ}: Q_{fec}=3.792). Model result are fairly sensitive to these options (Figures 2.29a and b, Tables 2.12a–d). A part justification for selecting the more conservative lower bound as the base case value was a deterioration in the fit to the Scottish survey abundance index as Qfec values increase, but this seems no longer to be the case and needs further exploration during the forthcoming benchmark meeting.

b) Alternative targeting scenarios

Alternatives targeting scenarios for both the post-1980s landings data (for which data are available by nation) and the pre-1980s landings data (not available by nation) were explored in this set of sensitivity analyses presented in ICES (2011) and shown again here. The alternative scenarios are listed in Section 2.9.2, and results shown in Figure 2.30. These results indicate a general lack of sensitivity to alternative assumptions about targeting.

2.9.6 MSY $B_{trigger}$

As with surplus production models such as SPiCT, the spurdog assessment estimates reference points each time the assessment is run (see Stock Annex). The current estimates of B_{MSY} for spurdog is 947 895 t for the C_{SQ} assessment ("Base case" in Tables 2.12b). According to ICES guidelines (ICES, 2017), MSY $B_{trigger}$ represents the 5th percentile of the distribution of B_{MSY} in cases where B_{MSY} is estimable and has been "observed" by the assessment; this is indeed the case for spurdog (with the model stretching back to the virgin state), so we approximate the 5th percentile of the B_{MSY} distribution by setting MSY $B_{trigger} = B_{MSY}/1.4$ (see second bullet on page 16 of ICES, 2017, for the approach). This leads to an MSY $B_{trigger}$ value of 677 068 t for the assessments.

2.9.7 Projections

The base case assessment (see Tables 2.12) is used as a basis for future projections under a variety of catch options. These are based on:

- The ICES MSY rule, which assumes that $F_{prop,MSY} = 0.033$ and $MSY\ B_{trigger}$ = 677 068 t (Tables 2.12b and Section 2.9.6; this rule fishes at $F_{prop,MSY} = 0.033$ for total biomass values at or above $MSY\ B_{trigger}$, but reduces fishing linearly when total biomass is below $MSY\ B_{trigger}$ by the extent to which total biomass is below $MSY\ B_{trigger}$);
- Zero catch (for comparison purposes);
- TAC_{2009} = 1422 t, the last non-zero TAC set for spurdog in 2009;
- C_{SQ}: average landings for 2007–2009 = 2468 tan amount that could accommodate bycatch in mixed fisheries;
- Fishing at $F_{prop,MSY} = 0.033$ (the MSY harvest rate).

Results are given in Tables 2.15a , expressed as total biomass in future relative to the total biomass in 2020, and are illustrated in Figures 2.31. Results relative to MSY $B_{trigger}$ are given in Tables 2.15b . Recovery to MSY $B_{trigger}$ for the most conservative catch options (zero, TAC 2009, ave. catch 2007–9) from 2020 are 16, 18 and 19 years, with the remaining options (MSY approach and MSY harvest rate) taking longer than 30 years (point estimates in Tables 2.15b).

2.9.8 Conclusion

In 2020, WGEF presented two assessments; the base case which uses a constant catch assumption for 2010+ (as assumed in previous years; taken as the average catch 2007–9: C_{SQ}), and one assuming the harvest rate has been constant since 2010 (at the average harvest rate 2007-: $HR_{SQ)}$ (ICES, 2020). At the 2020 ADG, the base case model (C_{SQ}) was chosen as the final assessment to provide advice. The main reason for this was to keep the basis to the advice similar given the, at that time, expected 2021 benchmark (WKNSEA, ICES 2021).

Although the base case assessment (C_{SQ}) has a retrospective pattern, which first surfaced at the last assessment (ICES, 2018), it is still well within the 95% confidence limits of the assessment, with absolute Mohn's rho values less than 0.2, and the model provides reasonable fits to most of the available data. Sensitivity tests show the model to be sensitive to the range of Q_{fec} values that fall within the 95% probability interval for corresponding fecundity parameters, and the conservative choice of Q_{fec} at the lower end of the 95% confidence limits for this parameter needs to be re-assessed at the forthcoming benchmark meeting. The model is relatively insensitive to alternative targeting scenarios, including assumptions about selection patterns prior to 1980. Summary plot of the final assessments (the base case run), showing landings and estimates of recruitment, mean fishing proportion (with F_{prop}, MSY = 0.033) and total biomass (with MSY

$B_{trigger}$ = 677 068 t), together with estimates of precision, are given in Figures 2.32a and b and Tables 2.14a and b.

Results from the current model confirm that spurdog abundance has declined, and that the decline is driven by high exploitation levels in the past, coupled with biological characteristics that make this species particularly vulnerable to such intense exploitation. The assessment also confirms that the stock is starting to recover from a low in the mid-2000s.

A comparison with the 2018 assessment is provided in Figures 2.33a and d and shows a slight upward adjustment in recruitment and total biomass in recent years.

2.10 Quality of assessments

WGEF has attempted various analytical assessments of NE Atlantic spurdog using a number of different approaches (see Stock Annex and ICES, 2006). Although these exploratory models did not prove satisfactory (as a consequence of the quality of the assessment input data), they all indicated a decline in spurdog, as did previous analyses of survey data.

Whilst the current assessment model has been both benchmarked and published, there are a number of issues to consider, as summarised below.

2.10.1 Catch data

The WG has provided estimates of total landings of NE Atlantic spurdog and has used these, together with UK length–frequency distributions in the assessment of this stock. However, there are still concerns over the quality of these data as a consequence of:

- Uncertainty in the historical level of catches because of landings being reported by generic dogfish categories;
- Uncertainty over the accuracy of the landings data because of species misreporting;
- Lack of commercial length–frequency information for countries other than the UK (UK landings are a decreasing proportion of the total and therefore the length frequencies may not be representative of those from the fishery as a whole);
- Low levels of sampling of UK landings and lack of length–frequency data in recent years when the selection pattern may have changed due to the implementation of a maximum landing length (100 cm);
- Lack of discard information.

2.10.2 Survey data

Survey data are particularly important indicators of abundance trends in stocks such as this where an analytical assessment is not available. However, it should be highlighted that:

- The survey data used by WGEF cover only part of the stock distribution and analyses should be extended to other parts of the stock distribution;
- Spurdog survey data are difficult to interpret because of the typically highly skewed distribution of catch-per-unit of effort;
- Annual survey length–frequency distribution data (aggregated over all hauls) may be dominated by data from single large haul.

2.10.3 Biological information

As well as good commercial and survey data, the analytical assessments require good information on the biology of NE Atlantic spurdog. In particular, the WG would like to highlight the need for:

- Updated and validated age and growth parameters, in particular for larger individuals;
- Better estimates of natural mortality.

2.10.4 Assessment

As with any stock assessment model, the assessment relies heavily on the underlying assumptions; particularly with regard to life-history parameters (e.g. natural mortality and growth), and on the quality and appropriateness of input data. The inclusion of two periods of fecundity data has provided valuable information that allows estimation of Q_{fec}, and projecting the model back in time is needed to allow the 1960 fecundity dataset to be fitted. Nevertheless, the model has difficulty estimating both Q_{fec} and the fecundity parameters simultaneously, and additional information, such as on appropriate values of *MSYR* for a species such as spurdog, and possibly also additional fecundity data (which are now available but have not been included), would help with this problem. Further refinements of the model are possible, such as including variation in growth. Selectivity curves also cover a range of gears over the entire catch history, and more appropriate assumptions (depending on available data) could be considered. A check should be kept on the recent development of a retrospective pattern, although this is still well within the 95% confidence limits of assessment estimates, with absolute Mohn's rho values less than 0.2.

In summary, the model is considered appropriate for providing an assessment of spurdog, though the availability and applicability of the following data were examined during the 2021 benchmark (WKNSEA, ICES 2021):

- Selectivity parameters disaggregated by gear for the main fisheries (i.e. for various trawl, longline and gillnets);
- Appropriate indices of relative abundance from fishery-independent surveys, with corresponding estimates of variance;
- Improved estimates for biological data (e.g. growth parameters, reproductive biology and natural mortality);
- Inclusion of additional fecundity data;
- Information on likely values of *MSYR* for a species such as spurdog.

2.11 Reference points

As with surplus production models such as SPiCT, the spurdog assessment estimates reference points each time the assessment is run (see Stock Annex).

MSY considerations: In 2020, the exploitation status of the stock was considered to be below $F_{prop,MSY}$, as estimated from the results of the assessment. However, biomass has declined to record low levels in recent years, and therefore to allow the stock to rebuild, catches should be reduced to the lowest possible level in 2021 and 2022. Projections assuming application of the average landings for 2007–9 (C_{SQ}) (which would accommodate bycatch in mixed fisheries) suggest that the stock will rebuild by 5–10% of its 2020 level by 2023 (Table 2.15a).

$F_{prop,MSY}$ = 0.033, as estimated by the current assessment, assuming a non-target selection pattern.

2.12 Benchmark 2021

In February 2021, a benchmark for spurdog was held as part of WKNSEA (ICES 2021).

Summary of the benchmark:

The **spurdog** assessment is the only elasmobranch category 1 assessment with an integrated age–length-based assessment that includes catch data back to 1905. Survey indices included in the assessment only covered a relatively small part (primarily divisions 6.a and 4.a) of the entire stock distribution area. As such, one of the main aims of the benchmark was to improve spatial coverage by including a number of eligible surveys in the assessment. Further, the inclusion of new fecundity data along with improved information on growth was on the issue list. Finally, inclusion of fleet-based data (including length distributions), and better catch information since 2010 was to be addressed and a data-call was set up to request this information. Four main topics were considered in this benchmark (i) catch data (landings, discards and commercial size and sex composition), (ii) survey indices (biomass indices and size and sex composition), (iii) biological parameters, and (iv) reference points.

Based on the discussion on spatial and temporal coverage of the various surveys in DATRAS and those made available as part of the data call, the workshop agreed to derive three separate biomass indices, one per quarter (Q1, Q3, Q4). Data extraction and manipulation made use of the 'DATRAS' R package while statistical modelling has been carried out using the 'surveyIndex' R package (Berg et al., 2014). It implements a GAM modelling framework allowing for a variety of different model assumptions including 'delta' models with lognormal and gamma distributions for positive observations. In addition to the survey indices (and estimated CVs), the number of individuals by sex (sample size) and proportion at length by year (and sex) were calculated for use in the stock assessment. Details on the input data, analysis and results are found in the WD by Dobby (2021). This results in the following indices to be used in the assessment:

- A modelled Q1 index by sex, based on four survey time-series: NO-SH, NS-IBTS, SWC-IBTS, SCOWCGFS [1985–present].
- Q3 index by sex, based on a single survey: NS-IBTS [1992–present]
- A modelled Q4 index by sex, based on five survey time-series: SWC-IBTS, SCOWCGFS, NIGFS, IE-IGFS, EVHOE [2003–present].

Fecundity data used to inform the model were improved from having two data years (1960, 2005) to include 13 data years covering the time period 1921–2020.

For reference points B_{lim} was set to 20% of B0 as the model goes back to 1905 were reporting of landings were relatively low and well before the high exploitation in the 1950s and onwards. For detailed descriptions, please see the benchmark report ICES, 2021. Note that the first stock assessment following this benchmark will be done in 2021 and this chapter will be updated accordingly.

2.13 Conservation considerations

In 2007, the IUCN world redlist categorized Northeast Atlantic spurdog as 'Vulnerable', although the most recent assessment of spurdog in European waters lists spurdog as 'Endangered' (Nieto *et al*., 2015).

2.14 Management considerations

Perception of state of stock

All analyses presented in previous reports of WGEF have indicated that the NE Atlantic stock of spurdog declined over the second half of the 20th century, but now appears to be increasing. The current stock size is thought to be ca. 24% of virgin biomass.

Although spurdog are less frequently caught in groundfish surveys than they were 20 years ago, there is some suggestion that spurdog are now being more frequently seen in survey hauls, and survey catch rates are starting to increase (Figure 2.12).

Stock distribution

Spurdog in the ICES area are considered to be a single stock, ranging primarily from Subarea 1 to Subarea 8, although landings from the southern end of its range may also include other *Squalus* species.

Biological considerations

Spurdog is a long-lived and slow growing species which has a high age-at-maturity and is particularly vulnerable to high levels of fishing mortality. Furthermore, females are thought to have restricted movement (Thorburn *et al*., 2015). Population productivity is low, with low fecundity and a protracted gestation period. In addition, they form size- and sex-specific shoals and therefore aggregations of large fish (i.e. mature females) are easily exploited by target longline and gillnet fisheries.

Updated age and growth studies are required. For Norwegian waters, see Albert *et al*., 2019 and Section 2.14.

Fishery and technical considerations

Those fixed gear fisheries that capture spurdog should be reviewed to examine the catch composition, and those taking a large proportion of mature females should be strictly regulated.

During 2009 and 2010, a maximum landing length (MLL) was established in EC waters to deter targeting of mature females (see Section 2.10 of ICES, 2006 for simulations on MLL). Those fisheries taking spurdog that are lively may have problems measuring fish accurately, and investigations to determine an alternative measurement (e.g. pre-oral length) that has a high correlation with total length and is more easily measured on live fish are required. Dead spurdog may also be more easily stretched on measuring, and understanding such post-mortem changes is required to inform on any levels of tolerance, in terms of enforcement.

There is limited information on the distribution of gravid females with term pups and new-born spurdog pups, though they have been reported to occur in Scottish waters, in the Celtic Sea and off Ireland. The lack of accurate data on the location of pupping and nursery grounds, and their importance to the stock, precludes spatial management for this species at the present time.

2.15 Additional recent information

2.15.1 Developing an abundance index for spurdog in Norwegian waters

Input data to the assessment model have so far been restricted to the British sector, and data from other areas have been requested. In Norwegian waters, from where more than 80% of the current landings originate, there is no dedicated survey for spurdog, but data are recorded on all regular surveys, as well as by the Norwegian Reference fleet, and during official controls of commercial catches and landings. Two WDs were presented at 2016 WGEF meeting to indicate the potential for establishing one or several new tuning fleets in Norwegian waters to inform future assessments of this stock. An update was presented at 2020 WGEF.

Here are shown the updated trends from the Shrimp Survey in South-Norway (divisions 3.a and 4.a), the Coastal Survey in North-Norway (Division 2.a) and from samples from the commercial fleet in Norwegian waters. Details of the calculations were given in Albert and Vollen (2015 WD), Albert (2016 WD), Vollen and Albert (2016 WD), and Junge *et al*. (2020 WD).

The Shrimp Survey shows a rather clear pattern, with relatively high and fluctuating survey indices in the 1980s, low and decreasing values throughout the 1990s, reaching the lowest values in 2002, and then a return to high and variable values since 2003 (Figure 2.34; updated in Figure 2.14 and shown in strata in Figure 2.15). The Coastal Survey shows highly variable survey indices, with slight tendencies of higher values between 2000–2010 than in both the preceding and the following years (Figure 2.34). The percent of occurrence of spurdog in sampled catches from Norwegian commercial gillnetters shows an increasing trend throughout the most recent decade, and similar trends are also present from some other fleets (Figure 2.35).

All of these time series are crude estimates without proper stratification, and should only be regarded as preliminary indications of overall trends. Before the next benchmarking process of spurdog, more elaborated indices of abundance and composition should preferably be documented for this northern part of the distribution range.

2.15.2 Recent life-history information

The most recent update of biological data for *S. acanthias* in the North East Atlantic are from Norwegian waters (Albert *et al*., 2019). A total of 3948 bycaught individuals were sampled throughout the period from 2014–2018, within the ICES divisions 2.a, 4.a, and 3.a. Overall, females accounted for 56% of the samples, but the sex compositions of individual catches were highly skewed.

The sampled spurdog varied in length from 41 to 95 cm and 53 to 121 cm for males and females, respectively. The mean lengths of both males and females were larger in the northern area of the study.

The age composition was similar for both sexes, observed from the age of 3 up to the med-30s with dominance of individuals <15 years of age. Median age for both sexes was 11 years, with an interquartile range of 9–14 and 8–17 for females and males, respectively.

The youngest and smallest mature females were 7 years and 68 cm, while the oldest and largest immature ones were 26 years and 100 cm. Mean age of late gravid females was 15.3 years, with an interquartile range of 12–16 years; estimated 50% maturity was 9.5 years and 77.8 cm. For males, very few immatures were recorded making estimation of 50% maturity uncertain.

Near-term females had a range of 1–19 pups and a mean of 7.2 pups. Difference between left and right uteri was a maximum of two pups for 92% of the near-term females. Mean pup length of near-term females was 24 cm, with 10 and 90 percentiles of 19 and 27 cm, respectively. Both the number and mean size of pups of near-term females increased with maternal length.

2.16 References

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Table 2.1. Northeast Atlantic spurdog. WG estimates of total landings of NE Atlantic spurdog (1947–2020).

Year	Landings (tonnes)	Year	Landings (tonnes)	Year	Landings (tonnes)
1947	16 893	1972	50 416	1997	15 347
1948	19 491	1973	49 412	1998	13 919
1949	23 010	1974	45 684	1999	12 384
1950	24 750	1975	44 119	2000	15 890
1951	35 301	1976	44 064	2001	16 693
1952	40 550	1977	42 252	2002	11 020
1953	38 206	1978	47 235	2003	12 246
1954	40 570	1979	38 201	2004	9 365
1955	43 127	1980	40 968	2005	7 101
1956	46 951	1981	39 961	2006	4 015
1957	45 570	1982	32 402	2007	2 917
1958	50 394	1983	37 046	2008	1 798
1959	47 394	1984	35 193	2009	1 980
1960	53 997	1985	38 674	2010	893
1961	57 721	1986	30 910	2011	435
1962	57 256	1987	42 355	2012	453
1963	62 288	1988	35 569	2013	336
1964	60 146	1989	30 278	2014	383
1965	49 336	1990	29 906	2015	263
1966	42 713	1991	29 562	2016	373
1967	44 116	1992	29 046	2017	296
1968	56 043	1993	25 636	2018	363
1969	52 074	1994	20 851	2019	455
1970	47 557	1995	21 318	2020	526
1971	45 653	1996	17 294		

Table 2.2. Northeast Atlantic spurdog. WG estimates of total landings by nation (1980–2019); “-” = no data available, “.” = zero catch, “+” = <0.5 tonnes Data from 2005 onwards revised during WKSHARK2. From 2005 Scottish landings data are combined with those from England and Wales, and presented as UK (combined).

Country	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Belgium	1097	1085	1110	1072	1139	920	1048	979	657	750	582	393	447	335	396	391
Denmark	1404	1418	1282	1533	1217	1628	1008	1395	1495	1086	1364	1246	799	486	212	146
Faroe Islands	0	22	0	0	0	0	0	0	0	6	2	3	25	137	203	310
France	17 514	19 067	12 430	12 641	8356	8867	7022	11 174	7872	5993	4570	4370	4908	4831	3329	1978
Germany	43	42	39	25	8	22	41	48	27	24	26	6	55	8	21	100
Iceland	36	22	14	25	5	9	7	5	4	17	15	53	185	108	97	166
Ireland	108	476	1268	4658	6930	8791	5012	8706	5612	3063	1543	1036	1150	2167	3624	3056
Netherlands	217	268	183	315	0	0	0	0	0	0	0	0	0	0	0	0
Norway	5925	3941	3992	4659	4279	3487	2986	3614	4139	5329	8104	9633	7113	6945	4546	3940
Poland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Portugal	2	0	0	0	0	0	1	5	3	2	128	188	250	323	190	256
Russia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spain	0	0	8	653	0	0	0	0	0	0	0	0	0	0	0	0
Sweden	399	308	398	300	256	360	471	702	733	613	390	333	230	188	95	104
UK (E&W)	9229	9342	8024	6794	8046	7841	7047	7684	6952	5371	5414	3770	4207	3494	3462	2354
UK (Sc)	4994	3970	3654	4371	4957	6749	6267	8043	8075	8024	7768	8531	9677	6614	4676	8517
Total	40 968	39 961	32 402	37 046	35 193	38 674	30 910	42 355	35 569	30 278	29 906	29562	29046	25636	20851	21318

Table 2.2 (continued). Northeast Atlantic spurdog. WG estimates of total landings by nation (1980–2019); "-" = no data available, "." = zero catch, "+" = <0.5 tonnes Data from 2005 onwards revised during WKSHARK2. From 2005 Scottish landings data are combined with those from England and Wales, and presented as UK (combined)

Country	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Belgium	430	443	382	354	400	410	23	11	13	21	17	11	12	7	1	0	0	0	-	-
Denmark	142	196	126	131	146	156	107	232	219	150	121	76	78	82	14	26	30	19	10	27
Faroe Islands	51	218	362	486	368	613	340	224	295	225	271	241	144	462	179	104	-	-	-	-
France	1607	1555	1286	998	4342	4304	2569	1705	1062	946	702	505	368	412	164	84	34	13	19	2
Germany	38	21	31	54	194	304	121	98	138	140	7	3	5	2	1	1	1	1	1	+
Iceland	156	106	80	57	107	199	276	200	142	76	82	43	68	102	62	53	51	6	19	8
Ireland	2305	2214	1164	904	905	1227	1214	1416	1076	1022	859	651	137	175	26	13	37	34	18	2
Netherlands	0	0	0	0	28	39	27	10	25	31	23	25	18	5	7	1	4	3	0	1
Norway	2748	1567	1293	1461	1643	1424	1091	1119	1054	1016	790	615	711	543	540	247	285	250	313	217
Poland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Portugal	120	100	46	21	2	3	4	4	9	5	9	10	4	3	2	3	2	2	1	2
Russia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spain	0	0	28	95	372	363	306	135	17	43	47	85	42	23	7	7	6	2	1	4
Sweden	154	196	140	114	123	238	0	275	244	169	147	93	75	80	5	0	-	-	-	-
UK (combined)*	2670	3066	4480	4461	3654	4516	2823	3109	1729	3481	1209	799	280	546	64	1	3	6	0	-
UK (Sc)*	6873	5665	4501	3248	3606	2897	2120	3708	3342											
Total	17 294	15 347	13 919	12 384	15 890	16 693	11 020	12 246	9365	7101	4015	2917	1798	1980	893	435	453	336	383	263

Table 2.2 (continued). Northeast Atlantic spurdog. WG estimates of total landings by nation (1980–2020); "-" = no data available, "." = zero catch, "+" = <0.5 tonnes. Data from 2005 onwards revised during WKSHARK2. From 2005 Scottish landings data are combined with those from England and Wales, and presented as UK (combined).

Country	2016	2017	2018	2019	2020
Belgium	-	-	-	-	
Denmark	24	27	19	21	32
Faroe Islands	-	-	-	-	-
France	1	3	1	-	-
Germany	2	+	1	+	-
Iceland	8	4	2	1	3
Ireland	34	1	24	11	3
Netherlands	1	1	6	+	+
Norway	270	222	271	370	409
Poland	-	-	-	-	-
Portugal	1	1	1	.	-
Russia	-	-	-	-	-
Spain	1	.	.	-	+
Sweden	+	+	+	+	-
UK (combined)*	30	37	38	52	79
UK (Sc)*					
Total	373	296	363	455	526

Table 2.3. Northeast Atlantic spurdog. WG estimates of landings by ICES Subarea (1980–2019). Data from 2005 onwards revised during WKSHARK2.

Subarea or Division	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Baltic	0	0	0	0	0	0	0	1	0	0	0	1	3	0	0	0	0	0
1 and 2	138	20	28	760	40	120	137	417	1559	2808	4296	6614	5063	5102	3124	2725	1853	582
3 and 4	20 544	16 181	11 965	11 572	10 557	11 136	8986	11 653	10 800	10 423	11 497	9264	10 505	6591	4360	7347	5299	4977
5	45	27	18	27	5	22	9	41	6	73	182	133	336	335	364	484	217	320
6	4590	4011	5052	7007	8491	12422	8107	9038	7517	6406	5407	6741	6268	5927	5622	5164	4168	3412
7.a	2722	4013	4566	4001	6336	6774	6458	7305	5569	3389	2801	2527	2669	2700	2313	1185	1650	1534
7.b-c	704	925	424	1777	2178	1699	1197	2401	1579	893	369	293	316	2009	1175	1004	603	450
7.d-f	6693	8210	5989	4664	2450	1280	1644	2892	2120	1634	1339	1122	852	785	800	760	852	646
7.g-k	4793	5479	3881	6924	4902	4965	3864	8106	6175	4477	3736	2495	2622	1745	2680	2034	2229	2984
8	739	1095	479	312	234	257	507	497	242	174	273	367	406	435	406	602	408	418
9	0	0	0	0	0	0	1	4	1	2	4	4	2	5	7	5	2	2
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	12
14	0	0	0	0	0	0	0	0	0	0	0	0	4	1	0	0	0	0
Other or unspecified	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	12	10
Total	40 968	39 961	32 402	37 046	35 193	38 674	30 910	42 355	35 569	30 278	29 906	29 562	29 046	25 636	20 851	21 318	17 294	15 347

Table 2.3 (continued) Northeast Atlantic spurdog. WG estimates of landings by ICES Subarea (1980–2019). Data from 2005 onwards revised during WKSHARK2.

Subarea or Division	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Baltic	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1 and 2	607	779	894	462	357	440	423	682	499	312	337	230	190	93	131	74	122	105
3 and 4	3895	2705	2475	2516	1904	2395	2163	1177	789	628	642	635	400	183	189	198	203	140
5	442	545	879	1406	808	583	677	244	204	161	86	103	63	53	51	6	28	8
6	2831	2715	5977	5624	3169	3398	2630	1581	830	619	169	263	69	3	1	0	0	+0
7.a	1771	2153	1599	1878	1529	2021	938	589	413	272	73	97	3	1	10	4	2	+
7.b-c	854	1037	1028	816	527	588	432	332	268	299	48	97	7	1	1	0	0	0
7.d-f	443	411	438	555	295	268	278	285	168	172	124	196	78	71	33	17	8	+
7.g-k	2656	1822	2161	2846	2130	2339	1739	2005	746	386	245	288	63	14	29	30	16	2
8	308	171	405	469	269	134	56	138	87	58	70	65	15	12	3	3	2	2
9	2	3	19	8	11	5	14	5	10	11	5	6	5	5	5	3	2	6
10	0	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	104	22	14	41	22	74	12	4	1	0	0	0	0	0	0	0	0	0
14	0	0	0	63	0	0	0											
Other or unspecified	6	4	1	2	0	0	0	59	0	0	0	0	0	0	0	0	0	0
Total	13 919	12 384	15 890	16 693	11 020	12 246	9365	7101	4015	2917	1798	1980	893	435	453	336	383	263

Table 2.3 (continued) Northeast Atlantic spurdog. WG estimates of landings by ICES Subarea (1980–2020). Data from 2005 onwards revised during WKSHARK2.

Subarea or Division	2016	2017	2018	2019	2020
Baltic	0	0	0	0	0
1 and 2	150	127	164	183	280
3 and 4	165	123	128	208	156
5	8	4	2	0	3
6	5	1	3	0	5
7.a	2	0	+	+	+
7.b-c	3	0	0	0	0
7.d-f	1	14	19	14	28
7.g-k	36	24	45	49	53
8	1	1	+	0	+
9	2	1	1	0	0
10	0	0	0	0	0
12	0	0	0	0	0
14	0	0	1	0	0
Other or unspecified	0	0	0	0	0
Total	373	296	363	455	526

Table 2.4. Northeast Atlantic spurdog. Norwegian Shrimp and Coastal survey, 1984–2017. Month of survey, mean duration of tows, total number of stations, number of stations with spurdog, total number of spurdog caught, and mesh size used. Source: Vollen and Albert (2016 WD).

Year	Survey	Month of survey	Mean duration (h)	# of stations	# of stations with spurdog	# spurdogs caught	Mesh size	Survey	Month of survey	Mean duration (h)	# of stations	# of stations with spurdog	# spurdogs caught	Mesh shze
1984	S	10–11	0.96	59	10	67								
1985	S	10–11	1.00	86	29	303								
1986	S	10–11	0.96	57	26	341								
1987	S	10–11	0.99	93	29	90								
1988	S	10–11	0.97	102	29	87								
1989	S	10–11	0.50	89	11	18	35							
1990	S	10–11	0.49	77	19	130	35							
1991	S	10–11	0.52	101	11	38	35							
1992	S	10–11	0.50	99	12	22	35							
1993	S	10–11	0.50	106	10	14	35							
1994	S	10–11	0.47	101	10	18	35							
1995	S	10–11	0.48	102	8	15	35	C	9–10	0.43	29	6	22	40
1996	S	10–11	0.50	103	4	15	35	C	9–10	0.45	22	5	9	40
1997	S	10–11	0.49	93	10	18	35	C	8–9	0.42	44	1	2	20
1998	S	10–11	0.49	95	9	14	20	C	10–11	0.47	33	8	106	20
1999	S	10–11	0.50	97	4	7	20	C	10–11	0.44	34	2	4	20
2000	S	10–11	0.50	98	5	18	20	C	10–11	0.47	28	6	12	20
2001	S	10–11	0.50	70	2	3	20	C	10–11	0.42	17	5	64	20
2002	S	10–11	0.50	77	1	1	20	C	10–11	0.46	37	4	43	20
2003	S	10–11	0.53	68	12	34	20	C	10–11	0.44	23	4	21	20
2004	S	5–6	0.50	60	7	48	20	C	10–11	0.37	33	5	104	20
2005	S	5–6	0.51	86	7	12	20	C	10–11	0.46	18	2	17	20
2006	S	1–2	0.49	43	9	33	20	C	10–11	0.30	34	8	52	20
2007	S	1–2	0.50	64	14	27	20	C	10–11	0.35	36	7	35	20
2008	S	1–2	0.51	73	13	52	20	C	10–11	0.56	7	0	0	20
2009	S	1–2	0.47	92	16	39	20	C	10–11	0.39	19	0	0	20
2010	S	1–2	0.47	95	20	34	20	C	10–11	0.36	26	3	25	20
2011	S	1–2	0.49	97	18	43	20	C	10–11	0.33	20	5	6	20
2012	S	1–2	0.47	63	14	71	20	C	10–11	0.36	31	5	9	20
2013	S	1–2	0.38	100	35	177	20	C	10	0.42	19	1	1	20
2014	S	1	0.47	68	18	99	20	C	10	0.39	30	3	4	20
2015	S	1	0.49	88	18	62	20	C	10-11	0.37	28	5	10	20
2016	S	1	0.50	105	19	51	20	C	10	0.37	27	2	37	20
2017	S	1	0.50	108	35	90	20	C	10-11	0.41	33	3	26	20

Table 2.5. Northeast Atlantic spurdog. Analysis of Scottish survey data. Summary of significance of terms in final delta-lognormal CPUE model.

Binomial model	Df	Deviance	Resid df	Resid dev	%	P(>|Chi|)
			7794	8767.4		
as.factor(year)	29	103.93	7765	8663.4	5%	2.28E-10
as.factor(month)	11	1284.25	7754	7379.2	66%	< 2.2e-16
as.factor(roundarea)	19	564.68	7735	6814.5	29%	< 2.2e-16

Lognormal model	Df	Deviance	Resid df	Resid dev	%	Pr(>F)
			1948	5783.1		
as.factor(year)	29	339.65	1919	5443.5	31%	2.52E-15
as.factor(Q)	3	476.72	1916	4966.8	44%	< 2.2e-16
as.factor(roundarea)	17	263.38	1899	4703.4	24%	1.69E-14

Table 2.6. Northeast Atlantic spurdog. Description of life-history equations and parameters.

Parameters	Description/values	Sources
M_a	Instantaneous natural mortality at age *a*: $M_a = \begin{cases} M_{pup} e^{-a \ln(M_{pup}/M_{adult})/a_{M1}} & a < a_{M1} \\ M_{adult} & a_{M1} \le a \le a_{M2} \\ M_{til} / [1 + e^{-M_{gam}(a-(A+a_{M2})/2)}] & a > a_{M2} \end{cases}$	
a_{M1}, a_{M2}	4, 30	expert opinion
M_{adult}, M_{til}, M_{gam}	0.1, 0.3, 0.04621	expert opinion
M_{pup}	Calculated to satisfy balance equation 2.7	
l_a^s	Mean length-at-age a for animals of sex *s* $l_a^s = L_\infty^s (1 - e^{-\kappa^s (a - t_0^s)})$	
L_∞^f, L_∞^m	110.66, 81.36	average from literature
κ^f, κ^m	0.086, 0.17	average from literature
t_0^f, t_0^m	-3.306, -2.166	average from literature
w_a^s	Mean weight at age *a* for animals of sex *s* $w_a^s = a^s (l_a^s)^{b^s}$	
a^f, b^f	0.00108, 3.301	Bedford *et al*. (1986)
a^m, b^m	0.00576, 2.89	Coull *et al*. (1989)
l_{mat00}^f	Female length at first maturity 70 cm	average from literature
P_a''	Proportion females of age a that become pregnant each year $P_a'' = \dfrac{P_{\max}''}{1 + \exp\left[-\ln(19)\dfrac{l_a^f - l_{mat50}^f}{l_{mat95}^f - l_{mat50}^f}\right]}$ where $P_{\max}''$ is the proportion very large females pregnant each year, and l_{matx}^f the length at which *x*% of the maximum proportion of females are pregnant each year	
$P_{\max}''$	0.5	average from literature
l_{mat50}^f, l_{mat95}^f	80 cm, 87 cm	average from literature

Table 2.7a. Northeast Atlantic spurdog. Landings used in the assessment (1905-2009), with the allocation to “Non-target” and “Target”. Estimated Scottish selectivity (based on fits to proportions by length category data for the period 1991–2004) is assumed to represent “non-target” fisheries, and estimated England and Wales selectivity (based on fits to proportions by length category data for the period 1983–2001) “target” fisheries. The allocation to “Non-target” and “Target” shown below is based on categorising each nation as having fisheries that are “non-target”, “target” or a mixture of these from 1980 onwards. An average for the period 1980–1984 is assumed for the “non-target”/”target” split prior to 1980, while all landings from 2008 onwards are assumed to come from “non-target” fisheries. Landings are used as catch in the assessment.

Year	Non-target	Target	Total	Year	Non-target	Target	Total	Year	Non-target	Target	Total
1905	3503	3745	7248	**1940**	4556	4872	9428	**1975**	21322	22797	44119
1906	1063	1137	2200	**1941**	4224	4516	8740	**1976**	21295	22769	44064
1907	690	738	1428	**1942**	5135	5490	10625	**1977**	20420	21832	42252
1908	681	728	1409	**1943**	3954	4227	8181	**1978**	22828	24407	47235
1909	977	1045	2022	**1944**	3939	4212	8151	**1979**	18462	19739	38201
1910	755	808	1563	**1945**	3275	3501	6776	**1980**	20770	20198	40968
1911	946	1011	1957	**1946**	5265	5630	10895	**1981**	20953	19009	39962
1912	1546	1653	3199	**1947**	8164	8729	16893	**1982**	16075	16327	32402
1913	1957	2093	4050	**1948**	9420	10071	19491	**1983**	17095	19951	37046
1914	1276	1365	2641	**1949**	11120	11890	23010	**1984**	15047	20147	35194
1915	1258	1344	2602	**1950**	11961	12789	24750	**1985**	17048	21626	38674
1916	258	276	534	**1951**	17060	18241	35301	**1986**	15138	15772	30910
1917	164	175	339	**1952**	19597	20953	40550	**1987**	19558	22798	42356
1918	218	233	451	**1953**	18464	19742	38206	**1988**	17292	18277	35569
1919	1285	1374	2659	**1954**	19607	20963	40570	**1989**	15355	14924	30279
1920	2125	2271	4396	**1955**	20843	22284	43127	**1990**	14390	15516	29906
1921	2572	2749	5321	**1956**	22691	24260	46951	**1991**	14034	15529	29563
1922	2610	2791	5401	**1957**	22023	23547	45570	**1992**	15711	13335	29046
1923	2733	2922	5655	**1958**	24355	26039	50394	**1993**	12268	13369	25637
1924	3071	3284	6355	**1959**	22905	24489	47394	**1994**	9238	11613	20851
1925	3247	3472	6719	**1960**	26096	27901	53997	**1995**	12104	9214	21318
1926	3517	3760	7277	**1961**	27896	29825	57721	**1996**	10026	7269	17295
1927	4057	4338	8395	**1962**	27671	29585	57256	**1997**	9158	6190	15348
1928	4602	4920	9522	**1963**	30103	32185	62288	**1998**	8509	5410	13919
1929	4504	4816	9320	**1964**	29068	31078	60146	**1999**	7233	5152	12385
1930	5758	6156	11914	**1965**	23843	25493	49336	**2000**	9283	6608	15891
1931	5721	6117	11838	**1966**	20642	22071	42713	**2001**	9513	7180	16693
1932	8083	8643	16726	**1967**	21320	22796	44116	**2002**	6169	5001	11170
1933	9784	10460	20244	**1968**	27085	28958	56043	**2003**	7167	5080	12247
1934	9848	10530	20378	**1969**	25166	26908	52074	**2004**	5718	3648	9366
1935	10761	11505	22266	**1970**	22983	24574	47557	**2005**	4234	4192	8426
1936	10113	10812	20925	**1971**	22063	23590	45653	**2006**	2670	1439	4109
1937	11565	12365	23930	**1972**	24365	26051	50416	**2007**	1846	1083	2929
1938	8794	9402	18196	**1973**	23880	25532	49412	**2008**	1836	0	1836
1939	9723	10396	20119	**1974**	22078	23606	45684	**2009**	2640	0	2640

Table 2.7b. Northeast Atlantic spurdog. Landings from 2010 onwards used in the assessment, with the allocation to "Non-target" and "Target" (see caption to Table 2.7a for more details). Landings from 2010 onwards are assumed to be either the average landings for 2007–2009 (left) or the average harvest rate for 2007–2009 (right). Landings are used as catch in the assessment.

Constant catch (ave 2007–2009)				Constant harvest rate (ave 2007–2009)			
Year	Non-target	Target	Total	Year	Non-target	Target	Total
2010	2468	0	2468	**2010**	2716	0	2716
2011	2468	0	2468	**2011**	2777	0	2777
2012	2468	0	2468	**2012**	2842	0	2842
2013	2468	0	2468	**2013**	2914	0	2914
2014	2468	0	2468	**2014**	2992	0	2992
2015	2468	0	2468	**2015**	3071	0	3071
2016	2468	0	2468	**2016**	3145	0	3145
2017	2468	0	2468	**2017**	3221	0	3221
2018	2468	0	2468	**2018**	3307	0	3307
2019	2468	0	2468	**2019**	3386	0	3386

Table 2.8. Northeast Atlantic spurdog. Delta-lognormal GLM-standardised index of abundance (with associated CVs), based on Scottish groundfish surveys.

Year	Index	CV
1990	156.8	0.31
1991	91.3	0.30
1992	78.4	0.30
1993	145.5	0.30
1994	128.5	0.33
1995	50.3	0.45
1996	86.1	0.33
1997	52.9	0.33
1998	82.4	0.33
1999	176.4	0.31
2000	75.5	0.34
2001	96.0	0.32
2002	96.4	0.31
2003	90.1	0.33
2004	64.4	0.35
2005	79.4	0.34
2006	63.6	0.33
2007	87.1	0.30
2008	76.1	0.33
2009	63.2	0.34
2010	86.1	0.45
2011	86.8	0.36
2012	72.9	0.36
2013	71.6	0.37
2014	159.5	0.31
2015	63.6	0.36
2016	153.1	0.31
2017	202.3	0.31
2018	127.9	0.33
2019	204.3	0.30

Table 2.9. Northeast Atlantic spurdog. Scottish survey proportions-by-length category for females (top) and males (bottom), with the actual sample sizes given in the second column.

	$n_{psur,y}$	16–31	32–54	55–69	70+
Females					
1990	539	0.0112	0.2685	0.1265	0.1272
1991	962	0.0636	0.1218	0.1092	0.1123
1992	145	0.1430	0.1514	0.2055	0.0424
1993	398	0.1259	0.1635	0.0788	0.1296
1994	1656	0.0744	0.2426	0.0519	0.0352
1995	2278	0.0572	0.3087	0.0779	0.1520
1996	230	0.0722	0.2381	0.0831	0.0684
1997	167	0.0438	0.2011	0.0955	0.0815
1998	446	0.0361	0.2404	0.1201	0.1731
1999	186	0.0316	0.0787	0.0331	0.1079
2000	1994	0.0962	0.2136	0.0456	0.1149
2001	118	0.0132	0.2060	0.0735	0.1363
2002	148	0.0428	0.0789	0.1773	0.1879
2003	224	0.0123	0.1578	0.0788	0.1898
2004	63	0.0412	0.0834	0.1240	0.0597
2005	121	0.0243	0.1434	0.1568	0.0756
2006	92	0.0360	0.1130	0.1727	0.0413
2007	152	0.0287	0.1773	0.1075	0.1657
2008	232	0.0708	0.1590	0.0127	0.1047
2009	233	0.0427	0.1175	0.2547	0.1167
2010	3495	0.1787	0.2687	0.1127	0.0002
2011	130	0.0183	0.1565	0.0684	0.1812
2012	808	0.0364	0.2320	0.0855	0.1316
2013	65	0.1713	0.2228	0.0146	0.1513
2014	608	0.0463	0.1701	0.0848	0.0873
2015	139	0.0535	0.1617	0.1744	0.1353
2016	670	0.0975	0.1383	0.1383	0.1456
2017	941	0.0758	0.1728	0.0817	0.1280
2018	275	0.0431	0.0882	0.1718	0.1165
2019	1439	0.0182	0.2127	0.0652	0.2199
Males					
1990	1044	0.0204	0.1300	0.0575	0.2587
1991	1452	0.0711	0.1273	0.0824	0.3123
1992	154	0.2324	0.0534	0.0504	0.1215
1993	644	0.0503	0.1202	0.1555	0.1762
1994	2467	0.0832	0.1809	0.1472	0.1847
1995	1905	0.0566	0.1259	0.0478	0.1738
1996	453	0.0597	0.1480	0.1237	0.2068

	$n_{psur,y}$	16–31	32–54	55–69	70+
1997	270	0.0228	0.1033	0.0803	0.3716
1998	436	0.0207	0.0974	0.0969	0.2155
1999	2045	0.0100	0.1144	0.0799	0.3255
2000	221	0.0141	0.1045	0.0753	0.3771
2001	264	0.0252	0.0654	0.1209	0.3016
2002	392	0.0209	0.0818	0.1257	0.3328
2003	190	0.0045	0.1397	0.1250	0.4225
2004	225	0.0297	0.0572	0.1506	0.3622
2005	180	0.0846	0.0992	0.1027	0.3505
2006	264	0.0044	0.1786	0.1423	0.1954
2007	395	0.0699	0.1482	0.0669	0.3678
2008	417	0.0252	0.1247	0.0719	0.2466
2009	2478	0.0028	0.1863	0.0644	0.1861
2010	567	0.0170	0.0896	0.0836	0.3853
2011	1278	0.0434	0.1249	0.0495	0.2968
2012	59	0.0242	0.1673	0.0639	0.1847
2013	1438	0.0463	0.1412	0.0668	0.3572
2014	207	0.0069	0.1532	0.0973	0.2177
2015	1095	0.0733	0.1134	0.1014	0.1922
2016	1581	0.0717	0.1194	0.1082	0.2423
2017	726	0.0534	0.1228	0.0579	0.3462

Table 2.10. Northeast Atlantic spurdog. Commercial proportions-by-length category (males and females combined), for each of the two fleets (Scottish, England & Wales), with raised sample sizes given in the second column.

	$n_{pcom,j,y}$	16–54	55–69	70–84	85+
Non-target (Scottish) commercial proportions					
1991	6167824	0.0186	0.4014	0.5397	0.0404
1992	6104263	0.0172	0.1844	0.7713	0.0272
1993	4295057	0.0020	0.2637	0.7106	0.0236
1994	3257630	0.0301	0.3322	0.5857	0.0520
1995	5710863	0.0112	0.2700	0.6878	0.0309
1996	2372069	0.0069	0.4373	0.5416	0.0142
1997	3769327	0.0091	0.3297	0.5909	0.0702
1998	3021371	0.0330	0.4059	0.5286	0.0325
1999	1869109	0.0145	0.3508	0.5792	0.0556
2000	1856169	0.00001	0.1351	0.7683	0.0967
2001	1580296	0.0021	0.2426	0.7022	0.0531
2002	1264383	0.0529	0.3106	0.5180	0.1186
2003	1695860	0.0011	0.2673	0.5729	0.1587
2004	1688197	0.0106	0.2292	0.6893	0.0708
Target (England & Wales) commercial proportion					
1983	243794	0.0181	0.4010	0.4778	0.1030
1984	147964	0.0071	0.2940	0.4631	0.2359
1985	97418	0.0015	0.1679	0.6238	0.2068
1986	63890	0.0004	0.1110	0.6410	0.2476
1987	116136	0.0027	0.1729	0.5881	0.2362
1988	168995	0.0085	0.0973	0.5611	0.3332
1989	109139	0.0011	0.0817	0.5416	0.3757
1990	39426	0.0168	0.1349	0.5369	0.3115
1991	42902	0.0013	0.1039	0.5312	0.3637
1992	23024	0.0003	0.1136	0.4847	0.4013
1993	15855	0.0012	0.1741	0.4917	0.3331
1994	14279	0.0026	0.2547	0.3813	0.3614
1995	48515	0.0007	0.1939	0.4676	0.3378
1996	16254	0.0082	0.3258	0.4258	0.2402
1997	22149	0.0032	0.1323	0.4082	0.4563
1998	21026	0.0007	0.1075	0.4682	0.4236
1999	9596	0.0037	0.1521	0.5591	0.2851
2000	10185	0.0001	0.0729	0.4791	0.4480
2001	17404	0.0024	0.1112	0.4735	0.4128

Table 2.11a. Northeast Atlantic spurdog. Fecundity data for 1960 (Ellis and Keable, 2008), given as length of pregnant female (l f) and number of pups (P'). Total number of samples is 783.

l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'
73	3	84	4	86	3	87	7	88	3	89	4	90	1	91	7	93	3	94	5	96	10	101	11
73	3	84	6	86	3	87	8	88	5	89	4	90	3	91	8	93	4	94	5	96	10	101	7
75	3	84	6	86	3	87	9	88	5	89	5	90	3	91	8	93	5	94	6	96	7	102	5
77	3	84	3	86	4	87	2	88	6	89	7	90	5	91	3	93	5	94	6	96	7	102	10
78	3	84	3	86	4	87	5	88	6	89	8	90	6	91	4	93	5	94	7	96	8	102	3
79	2	84	4	86	4	87	5	88	6	89	8	90	8	91	4	93	5	94	8	97	4	103	14
79	3	84	4	86	4	87	5	88	7	89	5	90	5	91	7	93	5	94	8	97	4	103	9
79	4	84	4	86	5	87	5	88	8	89	6	90	6	91	4	93	6	94	8	97	7	103	15
79	4	84	5	86	5	87	6	88	6	89	6	90	6	91	5	93	8	94	9	97	2	103	9
79	3	84	6	86	5	87	5	88	6	89	8	90	7	91	7	93	9	94	9	97	3	103	15
80	4	84	6	86	5	87	5	88	8	90	1	90	7	91	7	93	5	94	9	97	3	105	11
80	3	84	4	86	6	87	6	88	9	90	2	90	9	91	8	93	5	94	11	97	3	110	8
80	4	84	4	86	2	87	7	89	3	90	3	90	10	92	2	93	5	94	3	97	4	117	9
80	5	84	6	86	3	87	7	89	3	90	3	91	2	92	4	93	6	94	3	97	4		
80	2	84	6	86	4	87	7	89	4	90	3	91	3	92	5	93	6	94	8	97	4		
80	3	84	6	86	4	87	8	89	4	90	3	91	4	92	7	93	6	94	9	97	5		
80	3	84	6	86	5	87	9	89	4	90	5	91	5	92	2	93	8	94	9	97	6		
80	5	84	3	86	5	88	2	89	6	90	5	91	5	92	2	93	9	94	9	97	6		
81	1	84	4	86	5	88	2	89	2	90	5	91	6	92	2	93	9	94	11	97	7		
81	3	84	4	86	5	88	2	89	2	90	6	91	6	92	2	93	4	95	3	97	3		
81	3	84	4	86	6	88	4	89	3	90	7	91	7	92	2	93	6	95	6	97	5		
81	3	84	6	86	6	88	4	89	3	90	1	91	2	92	2	93	6	95	6	97	6		
81	6	84	6	86	7	88	5	89	3	90	2	91	2	92	3	93	6	95	8	97	7		
81	3	84	6	86	5	88	5	89	3	90	2	91	2	92	3	93	7	95	3	97	4		
81	3	84	6	86	6	88	5	89	3	90	3	91	2	92	3	93	9	95	4	97	6		
82	3	85	3	86	7	88	5	89	3	90	3	91	2	92	3	93	9	95	4	97	8		
82	4	85	3	86	7	88	6	89	4	90	3	91	3	92	3	93	9	95	4	97	9		
82	4	85	4	86	7	88	1	89	4	90	3	91	3	92	4	93	9	95	5	97	9		
82	4	85	5	86	8	88	2	89	4	90	4	91	4	92	4	93	9	95	7	97	4		
82	5	85	5	86	1	88	3	89	4	90	4	91	4	92	5	93	10	95	7	97	6		
82	6	85	5	86	2	88	3	89	4	90	4	91	4	92	5	93	11	95	7	97	7		
82	1	85	5	86	2	88	3	89	4	90	4	91	4	92	6	93	1	95	9	97	7		
82	4	85	5	86	3	88	3	89	4	90	4	91	4	92	6	93	4	95	6	97	9		
82	4	85	7	86	4	88	3	89	4	90	4	91	4	92	6	93	7	95	9	97	6		
82	6	85	1	86	5	88	3	89	4	90	5	91	4	92	6	93	4	95	7	97	8		
82	6	85	3	86	6	88	4	89	4	90	5	91	5	92	7	93	6	95	8	97	9		
82	5	85	3	86	7	88	4	89	5	90	5	91	5	92	7	93	6	95	10	98	1		
82	6	85	3	86	7	88	4	89	5	90	5	91	5	92	8	93	6	95	11	98	5		
82	5	85	4	86	7	88	4	89	5	90	5	91	5	92	9	93	7	95	11	98	6		
82	6	85	4	86	8	88	5	89	5	90	6	91	6	92	4	93	9	95	11	98	9		
82	5	85	4	87	2	88	5	89	5	90	6	91	6	92	5	93	9	95	4	98	9		
83	3	85	5	87	3	88	5	89	5	90	6	91	6	92	6	93	9	95	7	98	8		
83	2	85	5	87	4	88	5	89	6	90	8	91	6	92	6	93	9	95	8	98	8		
83	2	85	3	87	5	88	5	89	6	90	9	91	6	92	6	93	10	95	11	98	9		
83	3	85	4	87	6	88	5	89	6	90	4	91	7	92	7	93	11	95	11	98	12		
83	4	85	4	87	3	88	5	89	6	90	4	91	7	92	8	94	5	95	11	98	8		
83	5	85	5	87	4	88	5	89	6	90	4	91	7	92	6	94	6	96	4	98	8		
83	4	85	5	87	4	88	6	89	6	90	5	91	7	92	6	94	6	96	4	98	9		
83	4	85	5	87	4	88	6	89	7	90	5	91	4	92	7	94	6	96	9	99	6		
83	5	85	6	87	5	88	6	89	4	90	5	91	4	92	10	94	7	96	4	99	6		
83	5	85	6	87	5	88	6	89	4	90	6	91	4	92	3	94	9	96	5	99	8		
83	5	85	6	87	5	88	6	89	4	90	6	91	4	92	3	94	3	96	5	99	4		
83	6	85	7	87	7	88	6	89	4	90	6	91	4	92	4	94	3	96	5	99	8		
83	4	85	4	87	3	88	4	89	4	90	6	91	5	92	5	94	3	96	5	99	15		
83	4	85	5	87	4	88	5	89	4	90	7	91	6	92	6	94	4	96	6	99	8		
83	4	85	7	87	5	88	5	89	5	90	7	91	6	92	6	94	4	96	6	100	6		
83	6	85	8	87	5	88	5	89	5	90	7	91	6	92	7	94	4	96	6	100	9		
83	4	85	3	87	5	88	6	89	6	90	7	91	6	92	7	94	5	96	6	100	10		
83	4	85	4	87	6	88	6	89	6	90	9	91	6	92	7	94	5	96	8	100	14		
83	4	85	5	87	6	88	6	89	6	90	9	91	7	92	10	94	5	96	5	100	7		
83	6	85	6	87	7	88	5	89	6	90	5	91	7	92	6	94	6	96	5	100	10		
84	3	85	7	87	7	88	5	89	7	90	6	91	7	93	1	94	6	96	6	100	14		

l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'
84	3	85	4	87	7	88	6	89	3	90	6	91	8	93	4	94	6	96	6	101	4		
84	3	86	2	87	5	88	6	89	5	90	6	91	8	93	5	94	7	96	8	101	6		
84	4	86	3	87	5	88	6	89	6	90	7	91	8	93	6	94	7	96	8	101	6		
84	6	86	3	87	5	88	6	89	6	90	7	91	8	93	7	94	7	96	7	101	10		
84	3	86	4	87	6	88	7	89	8	90	8	91	4	93	8	94	7	96	7	101	7		
84	3	86	5	87	6	88	8	89	8	90	9	91	5	93	1	94	7	96	8	101	9		
84	3	86	2	87	7	88	8	89	3	90	10	91	7	93	2	94	8	96	10	101	11		
84	4	86	2	87	7	88	9	89	3	90	1	91	7	93	2	94	4	96	10	101	9		

Table 2.11b. Northeast Atlantic spurdog. Fecundity data for 2005 (Ellis and Keable, 2008), given as length of pregnant female (l f) and number of pups (P'). Total number of samples is 179.

l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'	l^f	P'
84	6	92	9	94	11	97	5	98	12	100	7	101	14	102	13	103	11	105	16	107	11	109	18
87	8	92	5	95	7	97	12	98	7	100	12	101	9	102	12	103	11	105	15	107	12	109	13
89	6	92	8	95	9	97	7	98	13	100	11	101	14	102	13	103	11	105	15	107	15	109	16
89	6	92	9	95	10	97	12	98	13	100	12	101	10	102	5	103	16	105	5	107	16	110	15
89	5	92	3	95	11	97	14	98	10	100	8	101	10	102	13	104	14	105	16	107	17	110	10
89	3	93	5	96	11	97	14	98	7	100	9	101	10	102	12	104	11	105	19	107	12	110	13
89	8	93	3	96	10	97	7	98	12	100	10	101	12	102	17	104	12	105	11	108	16	111	19
89	5	93	9	96	7	97	7	98	12	100	9	102	17	102	13	104	14	105	8	108	13	112	17
90	9	93	4	96	7	98	12	98	10	100	9	102	3	103	14	104	14	105	17	108	16	112	12
90	7	93	11	96	11	98	12	99	10	100	12	102	15	103	11	104	15	105	13	108	14	112	16
90	9	94	8	96	10	98	7	99	11	100	14	102	16	103	14	104	13	106	16	108	14	113	15
90	4	94	6	97	12	98	16	99	8	101	17	102	13	103	14	104	14	106	16	108	12	113	21
91	6	94	9	97	6	98	8	99	11	101	13	102	10	103	13	104	17	106	14	109	15	114	14
91	6	94	5	97	8	98	11	99	12	101	13	102	12	103	16	105	15	106	7	109	13	116	16
92	8	94	9	97	8	98	5	99	11	101	6	102	13	103	15	105	12	107	12	109	10		

Table 2.12a. Northeast Atlantic spurdog. C_{SQ} assessment. Estimates of key model parameters, with associated Hessian-based estimates of precision (CV expressed as a percentage) for the base-case run, and two sensitivity tests for alternative values of Q_{fec}.

	Q_{fec} = 2.149 base case		Q_{fec} = 2.629		Q_{fec} = 3.792	
$N_0^{f,preg}$	93417	2.1%	80511	2.0%	61433	2.1%
Q_{fec}	2.149	2.2%	2.630	2.7%	3.793	3.5%
q_{sur}	0.00050462	21%	0.00049215	21%	0.00042988	16%
B_{depl05}	0.274	23%	0.364	24%	0.668	17%
B_{depl55}	0.334	23%	0.431	23%	0.725	16%

Table 2.12b. Northeast Atlantic spurdog. C_{SQ} assessment. Estimates of other estimates of interest for the base case run, and two sensitivity tests for alternative values for Q_{fec}. MSY $B_{trigger}$ is calculated as $B_{MSY}/1.4$.

	Q_{fec} = 2.149 base case	Q_{fec} = 2.629	Q_{fec} = 3.792
M_{pup}	0.730	0.638	0.480
a_{fec}	-11.915	-9.620	-7.007
b_{fec}	0.175	0.143	0.106
$F_{prop,msy}$	0.0333	0.0416	0.0578
MSY	22847	27167	34056
B_{MSY}	947895	864684	749088
MSY $B_{trigger}$	677068	617631	535063
MSYR	0.0337	0.0456	0.0705
$-\ln L_{tot}$	2150.14	2148.25	2150.16

Table 2.13. Northeast Atlantic spurdog. C_{SQ} assessment. Correlation matrix for some key estimable parameters for the base-case. Correlations with absolute values greater than 0.5 are shaded.

	$N_0^{f,preg}$	$S_{c2,non\text{-}tgt}$	$S_{c2,tgt}$	$S_{c3,non\text{-}tgt}$	$S_{c3,tgt}$	$S_{c4,non\text{-}tgt}$	$S_{c4,tgt}$	S_{s1}	S_{s2}	S_{s3}	S_{s4}	Q_{fec}	$\varepsilon_{r,11}$	$\varepsilon_{r,12}$	$\varepsilon_{r,13}$	$\varepsilon_{r,14}$	$\varepsilon_{r,15}$	q_{sur}
$N_0^{f,preg}$	1																	
$S_{c2,non\text{-}tgt}$	-0.11	1																
$S_{c2,tgt}$	-0.01	0.00	1															
$S_{c3,non\text{-}tgt}$	-0.23	0.41	0.01	1														
$S_{c3,tgt}$	-0.05	0.01	0.08	0.05	1													
$S_{c4,non\text{-}tgt}$	-0.30	0.43	0.01	0.88	0.07	1												
$S_{c4,tgt}$	-0.19	0.06	0.10	0.16	0.53	0.19	1											
S_{s1}	0.04	-0.04	-0.01	-0.09	-0.06	-0.10	-0.10	1										
S_{s2}	0.07	-0.05	-0.01	-0.11	-0.07	-0.13	-0.12	0.45	1									
S_{s3}	0.07	-0.04	-0.01	-0.08	-0.04	-0.09	-0.08	0.37	0.50	1								
S_{s4}	0.03	-0.03	-0.01	-0.08	-0.06	-0.08	-0.08	0.31	0.41	0.35	1							
Q_{fec}	0.03	0.05	0.01	0.17	0.17	0.17	0.22	-0.07	-0.05	0.01	-0.05	1						
$\varepsilon_{r,11}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.04	-0.02	0.00	-0.01	1					
$\varepsilon_{r,12}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.04	-0.03	-0.02	0.00	-0.01	-0.01	1				
$\varepsilon_{r,13}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.05	-0.01	0.00	-0.01	0.00	-0.01	1			
$\varepsilon_{r,14}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.04	-0.05	0.00	0.00	0.00	0.01	0.00	-0.01	1		
$\varepsilon_{r,15}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.06	-0.03	0.00	0.00	0.00	0.01	0.01	0.00	0.00	1	
q_{sur}	-0.31	0.02	0.00	-0.03	-0.13	-0.02	-0.12	-0.15	-0.26	-0.33	-0.33	-0.70	0.02	0.01	0.01	0.00	0.00	1

Table 2.14. Northeast Atlantic spurdog. C_{SQ} assessment. Summary table of estimates from the base case assessment: recruitment (thousands of pups), total biomass (t) and fishing proportion or harvest rate (with selectivity averaged over ages 5–30); and WG estimates of landings (t) used in the assessment. The final recruitment value is taken directly from the estimated stock-recruit relationship.

	R (thousand pups)	B_{tot} (t)	Catch (t)	F_{prop} (5–30)
1980	201978	610689	40968	0.0961
1981	186439	589858	39962	0.0968
1982	176741	569390	32402	0.0813
1983	175534	556001	37046	0.0951
1984	165603	536749	35194	0.0936
1985	155728	518118	38674	0.1057
1986	154396	495329	30910	0.0876
1987	151916	479593	42356	0.1237
1988	146326	451678	35569	0.1103
1989	149195	430545	30279	0.0986
1990	141481	414059	29906	0.1018
1991	150016	398381	29563	0.1051
1992	139977	382497	29046	0.1074
1993	125495	366360	25637	0.0999
1994	122513	353561	20851	0.0848
1995	110081	344800	21318	0.0878
1996	110676	335472	17295	0.0729
1997	111196	329881	15348	0.0654
1998	110517	325745	13919	0.0596
1999	108857	322461	12385	0.0534
2000	110300	320323	15891	0.0685
2001	109414	314278	16693	0.0734
2002	111693	307387	11170	0.0504
2003	117282	306239	12247	0.0554
2004	119778	304086	9366	0.0428
2005	122471	304972	8426	0.0388
2006	121151	306748	4109	0.0187
2007	126186	313169	2929	0.0131
2008	132629	321145	1836	0.0079
2009	140680	330671	2640	0.0111
2010	156007	340320	2468	0.0101
2011	139083	349172	2468	0.0099
2012	139111	358102	2468	0.0097
2013	144843	367455	2468	0.0094
2014	143472	376770	2468	0.0091
2015	148238	386343	2468	0.0089
2016	158787	396400	2468	0.0087

	R (thousand pups)	B_{tot} (t)	Catch (t)	F_{prop} (5–30)
2017	162968	406569	2468	0.0084
2018	166211	416836	2468	0.0082
2019	158133	426532	2468	0.0080
2020	171756	436999		0.0961

Table 2.15a. Northeast Atlantic spurdog. C_{SQ} assessment. Assessment projections under different future catch options. Estimates of begin-year total biomass relative to the total biomass in 2020 are shown, assuming that the catch in 2020 is 2486 tons (average landings for 2007–2009). Point estimates are given in the upper third of the table with corresponding lower and upper values (reflecting ±2 standard deviations) given in the middle and bottom third of the table. All landings from 2008 onwards are assumed to be taken by non-target fisheries only. The "+x yrs" in the first column is relative to 2020 (so "+3 yrs" indicates 2023).

	Medium-term projections				
	MSY approach	zero	TAC 2009	Ave catch 2007–2009	MSY harvest rate
average catch*	10327	0	1422	2468	12011
Point estimates					
+ 3 yrs	1.05	1.09	1.08	1.08	1.04
+ 5 yrs	1.08	1.15	1.14	1.13	1.05
+ 10 yrs	1.16	1.32	1.29	1.27	1.09
+ 30 yrs	1.42	2.15	2.05	1.98	1.28
Point estimates -2 standard deviations					
+ 3 yrs	1.02	1.06	1.06	1.05	1.01
+ 5 yrs	1.03	1.11	1.10	1.09	1.01
+ 10 yrs	1.05	1.25	1.22	1.20	1.02
+ 30 yrs	1.11	1.86	1.81	1.76	1.10
Point estimates +2 standard deviations					
+ 3 yrs	1.08	1.11	1.10	1.10	1.06
+ 5 yrs	1.13	1.19	1.17	1.16	1.09
+ 10 yrs	1.26	1.40	1.36	1.34	1.17
+ 30 yrs	1.74	2.43	2.29	2.19	1.45

*** "average catch" is the average for the projection period 2021–2049**

Table 2.15b. Northeast Atlantic spurdog. C_{SQ} assessment. As for Table 2.15a, but this table shows estimates of begin-year total biomass relative to MSY $B_{trigger}$ (see Table 2.12b).

	Medium-term projections				
	MSY approach	**zero**	**TAC 2009**	**Ave catch 2007–2009**	**MSY harvest rate**
average catch*	10327	0	1422	2468	12011
Point estimates					
+ 3 yrs	0.68	0.70	0.70	0.69	0.67
+ 5 yrs	0.70	0.74	0.73	0.73	0.68
+ 10 yrs	0.75	0.85	0.84	0.82	0.71
+ 30 yrs	0.92	1.38	1.32	1.28	0.82
Point estimates -2 standard deviations					
+ 3 yrs	0.65	0.68	0.67	0.67	0.64
+ 5 yrs	0.65	0.71	0.70	0.69	0.64
+ 10 yrs	0.64	0.78	0.76	0.75	0.64
+ 30 yrs	0.60	1.10	1.08	1.06	0.65
Point estimates +2 standard deviations					
+ 3 yrs	0.71	0.72	0.72	0.72	0.69
+ 5 yrs	0.75	0.78	0.77	0.76	0.72
+ 10 yrs	0.85	0.93	0.91	0.89	0.78
+ 30 yrs	1.23	1.67	1.56	1.49	1.00

*** "average catch" is the average for the projection period 2021–2049**

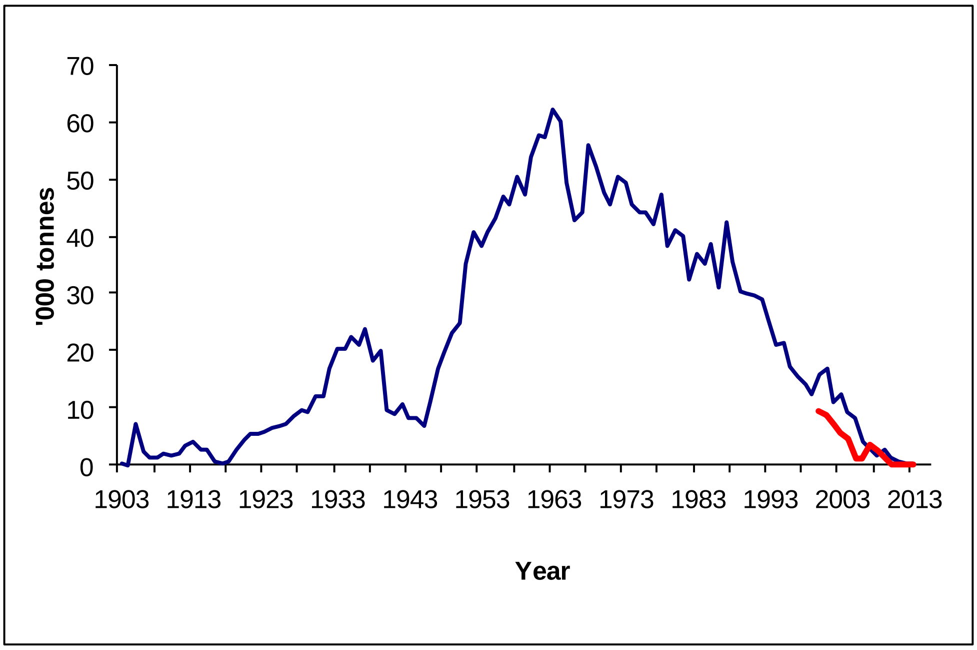


Figure 2.1. Northeast Atlantic spurdog. WG estimates of total international landings of NE Atlantic spurdog (1903–2013, blue line) and TAC (red line). Restrictive management (e.g. through quotas and other measures) is only thought to have occurred since 2007.

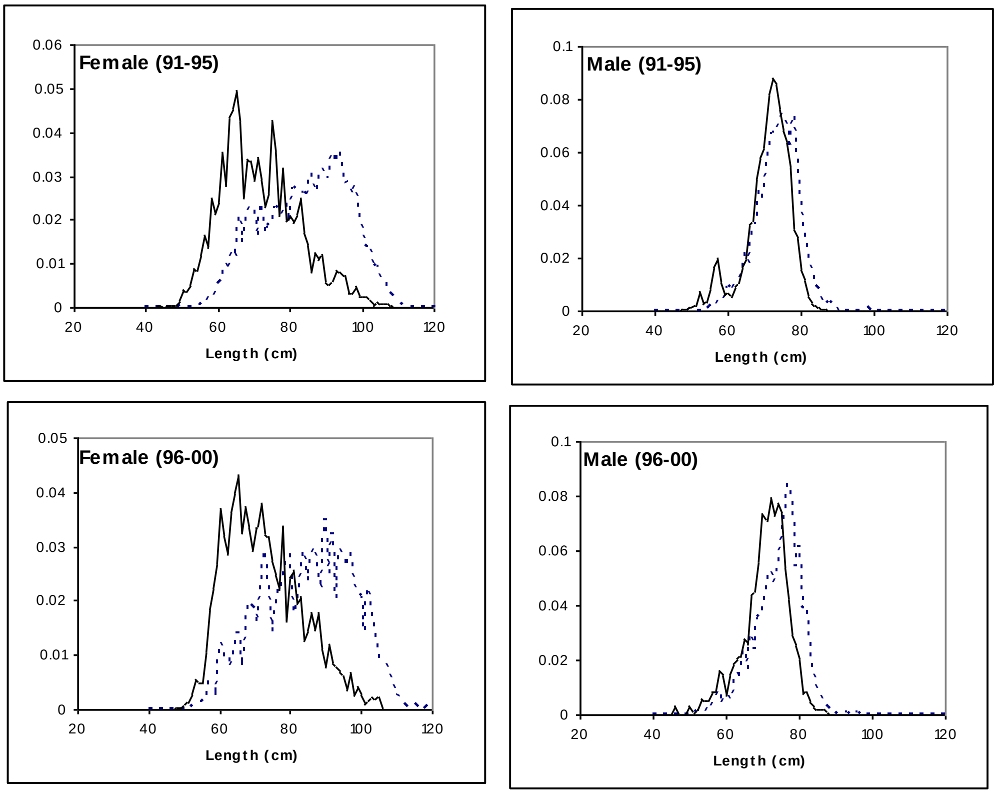


Figure 2.2. Northeast Atlantic spurdog. Comparison of length–frequency distributions (proportions) obtained from market sampling of Scottish (solid line) and UK (E&W) (dashed line) landings data. Data are sex-disaggregated, but averaged over five-year intervals.

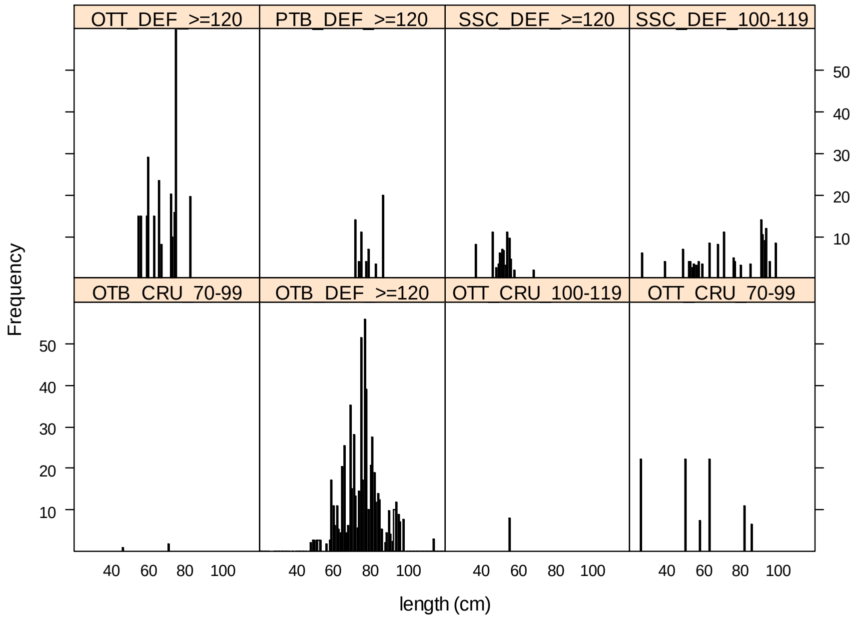


Figure 2.3. Northeast Atlantic spurdog. Length distributions of spurdog caught on Scottish observer trips in 2010. Data are aggregated across trips for each gear category. Gear codes relate to gear type, target species and mesh size. OTT – Otter trawl twin; PTB – Pair trawl bottom; SSC – Scottish Seine; OTB – Otter trawl bottom; DEF – demersal fish; CRU – crustacean.

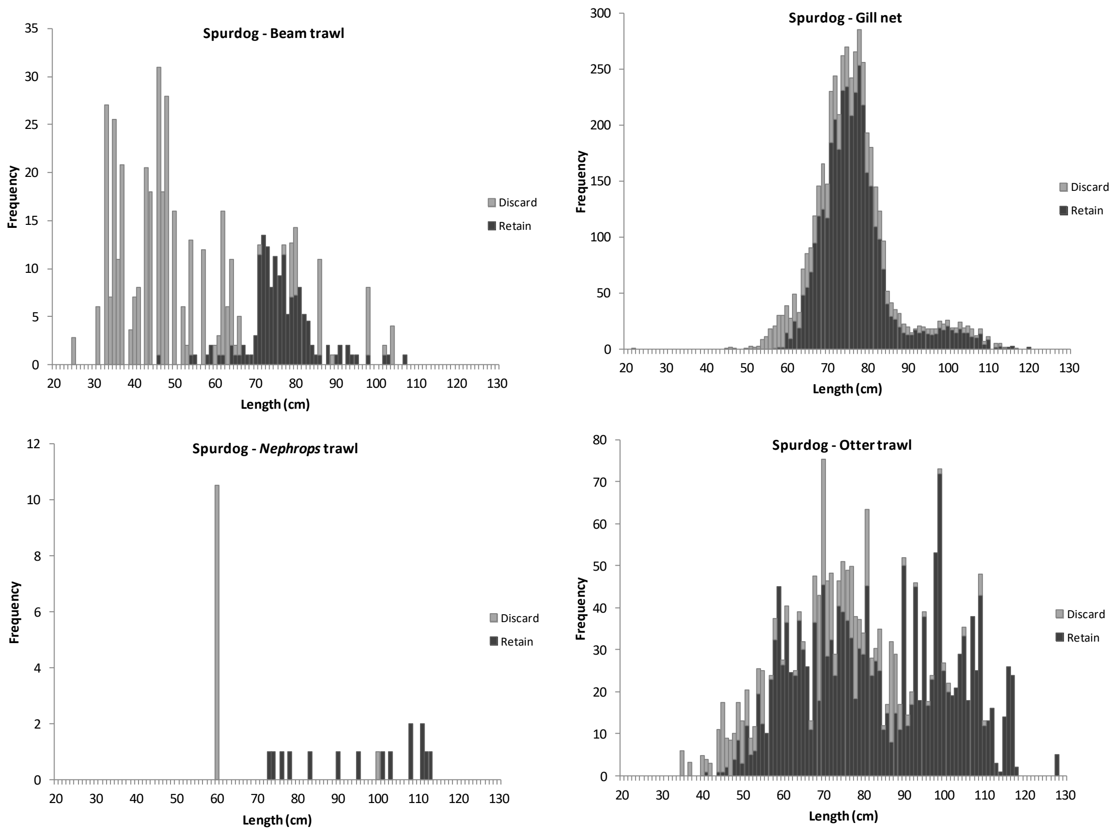


Figure 2.4. Northeast Atlantic spurdog. Discard-retention patterns of spurdog taken in UK (English) vessels using beam trawl, gillnet, *Nephrops* trawl and otter trawl.

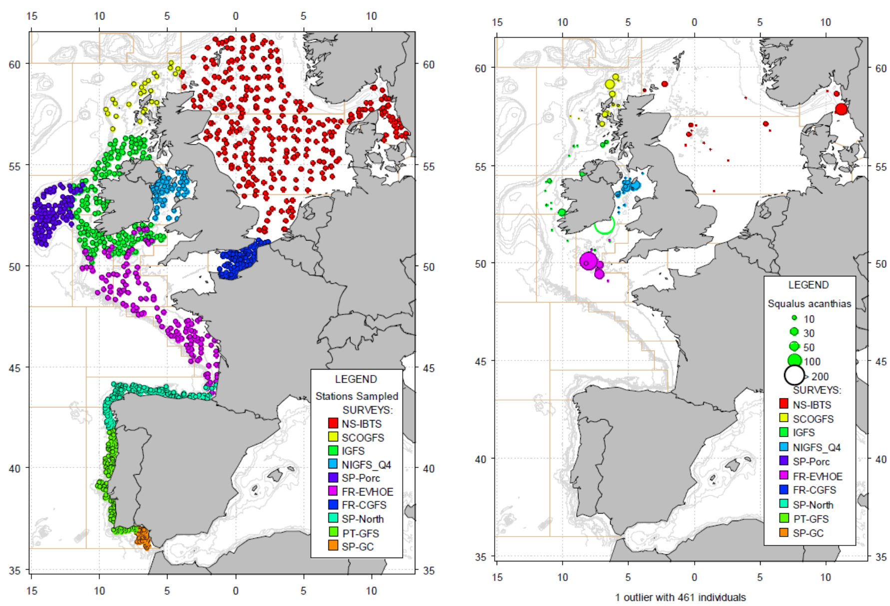


Figure 2.5. Northeast Atlantic spurdog. Overall spatial coverage of the IBTS (left) all surveys combined and (right) captures of spurdog (number per hour, bottom) as reported in the 2013 summer/autumn IBTS. The catchability of the different gears used in the NE Atlantic surveys is not constant; therefore, the map does not reflect proportional abundance in all the areas but within each survey (From ICES, 2014).

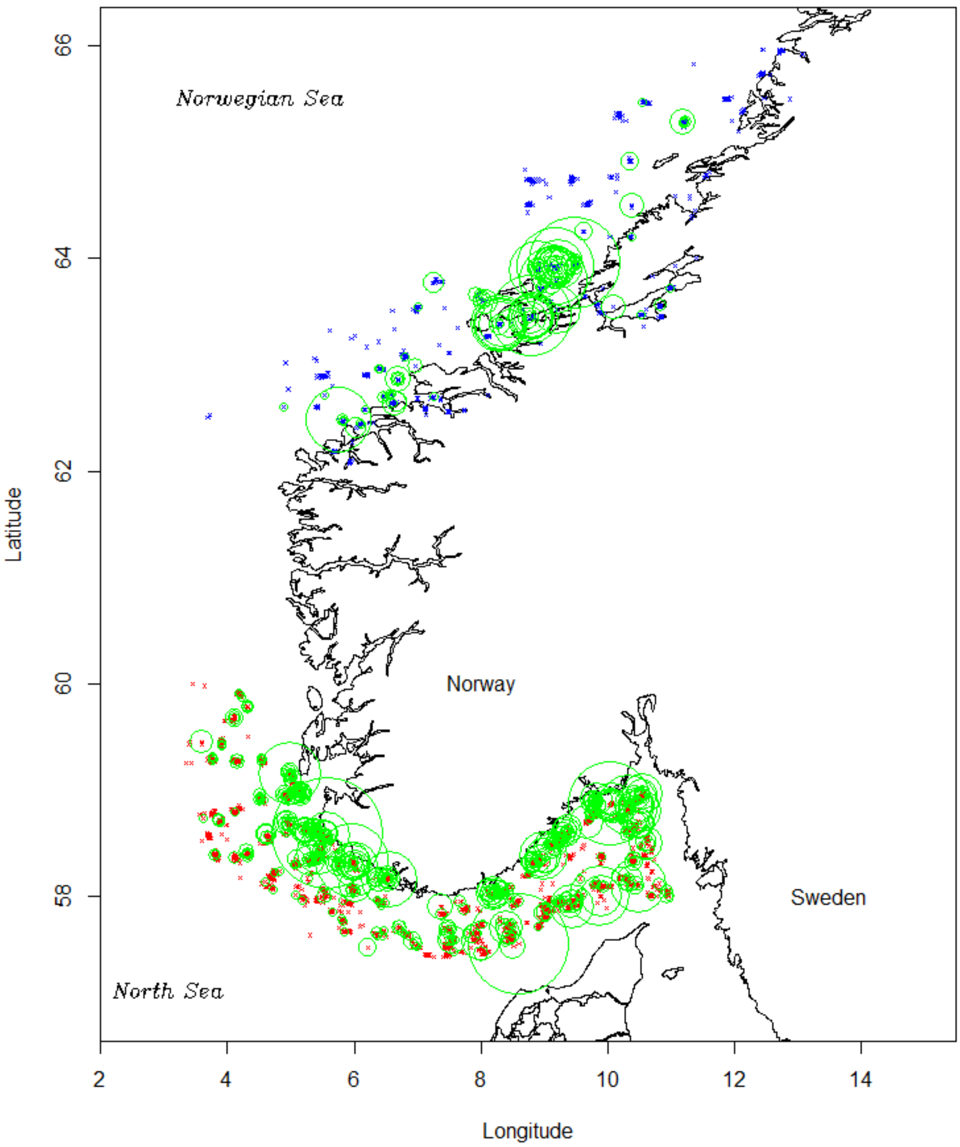


Figure 2.6. Northeast Atlantic spurdog. Map of survey areas with stations 1996–2017/18 for Coastal survey (blue) and Shrimp survey (red) for area 58–66°North. Green circles indicate catches of spurdog; circle area is proportional to catch in number of individuals. Source: Vollen (2014 WD), plus additional data from 2014 onwards.

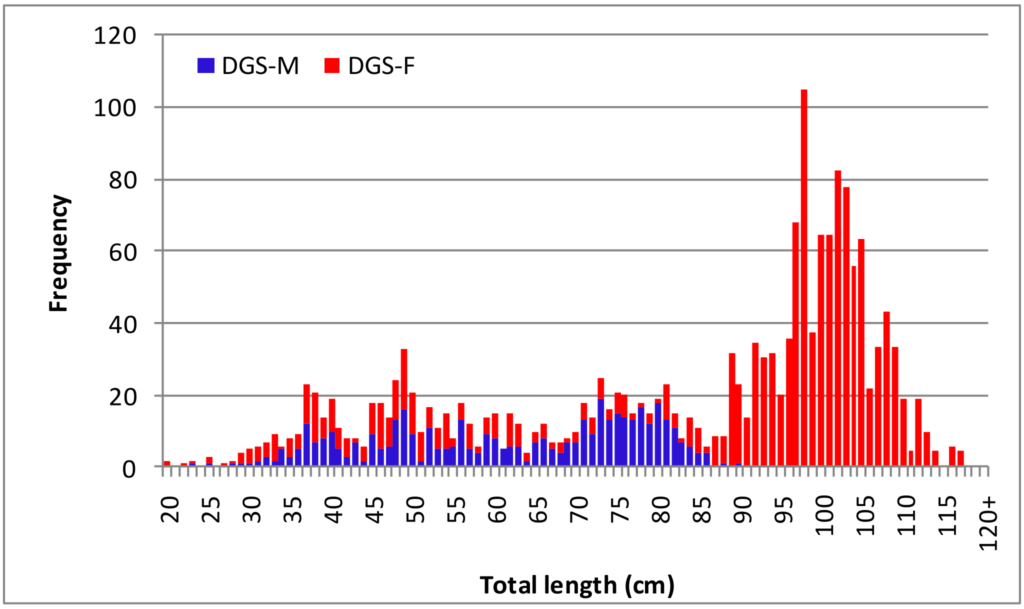


Figure 2.7a. Northeast Atlantic spurdog. Length distribution of spurdog captured in the UK (England and Wales) westerly IBTS in Q4 (2004–2009, all valid and additional tows). Length distribution highly influenced by a single haul of large females.

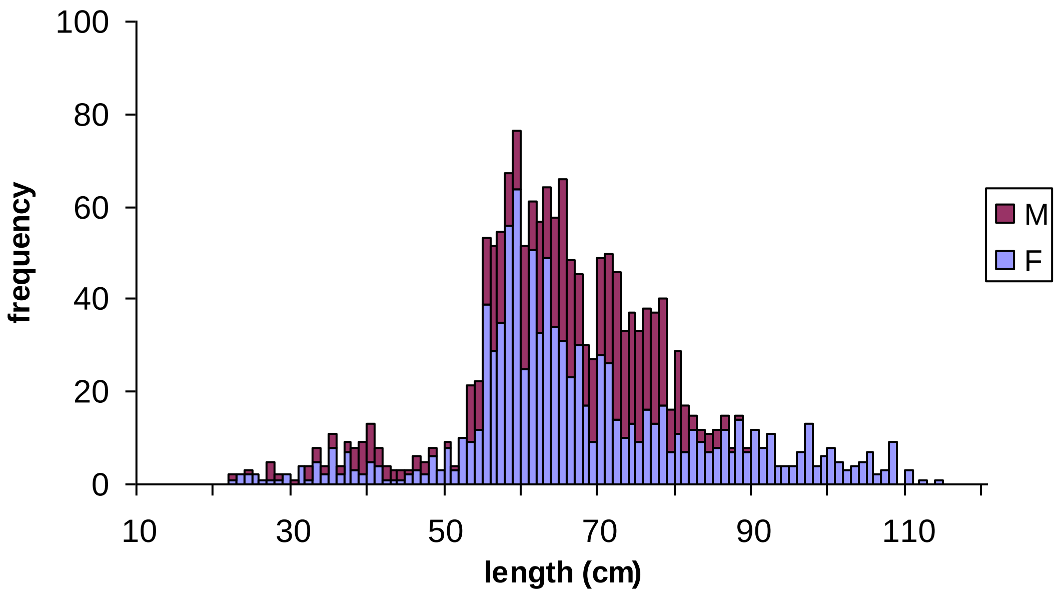


Figure 2.7b. Northeast Atlantic spurdog. Length distribution of spurdog captured in the Irish Q3 Celtic Seas groundfish survey (2003–2009).

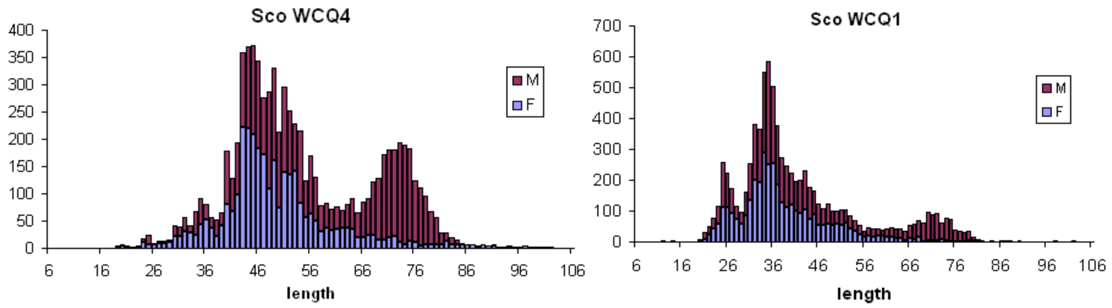


Figure 2.8. Northeast Atlantic spurdog. Length distribution of spurdog captured in the Scottish Q1 and Q4 groundfish surveys (1990–2010). Length–frequency distributions highly influenced by a small number of hauls containing many small individuals.

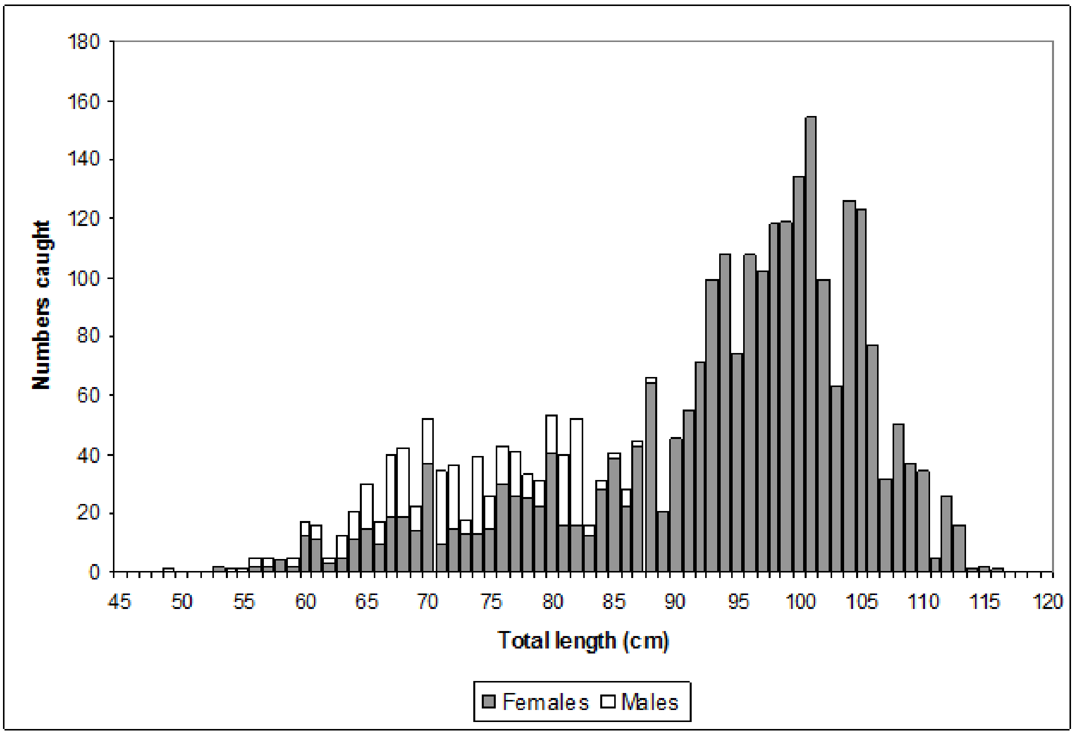


Figure 2.9. Northeast Atlantic spurdog. Total length–frequency of male and female spurdog taken during the UK(E&W) FSP survey, raised for those catches that were sub-sampled (n = 2517 females and 356 males).

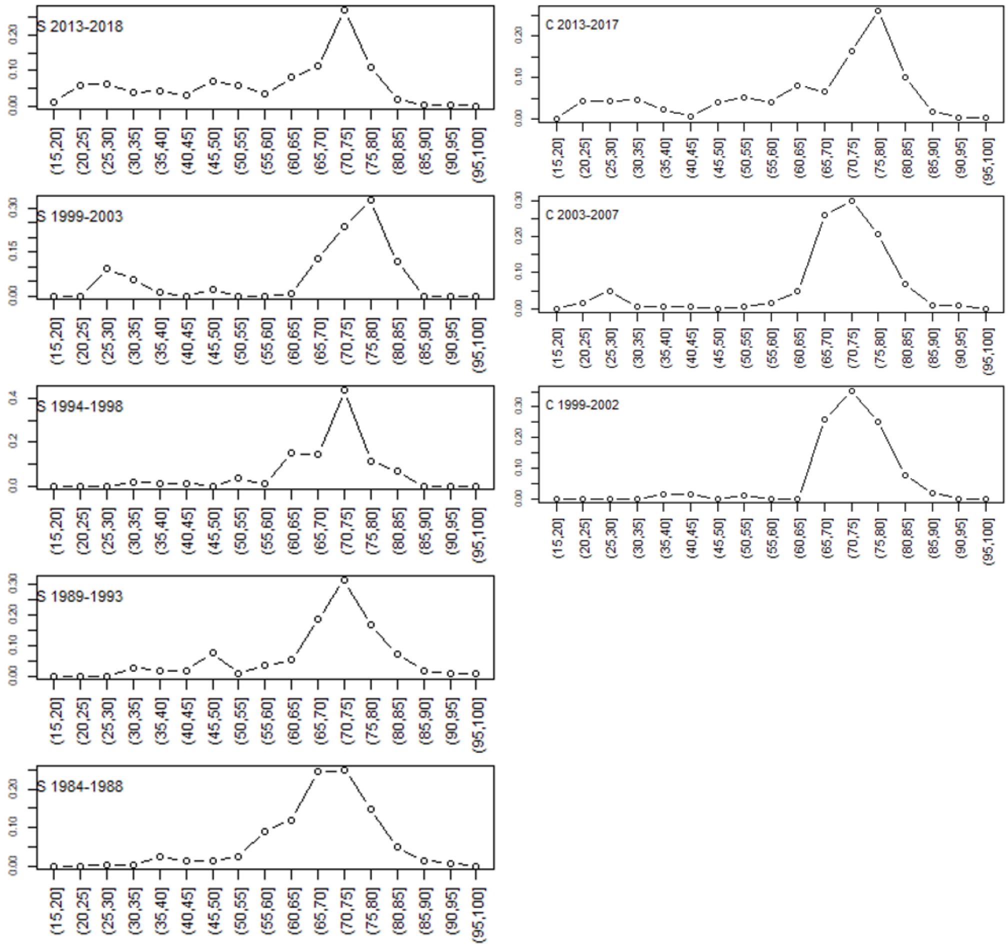


Figure 2.10. Northeast Atlantic spurdog. Relative length–frequency distributions (5 cm length groups and five-year periods) for the Shrimp survey 1985–2018 (left) and Coastal survey 1999–2017 (right).

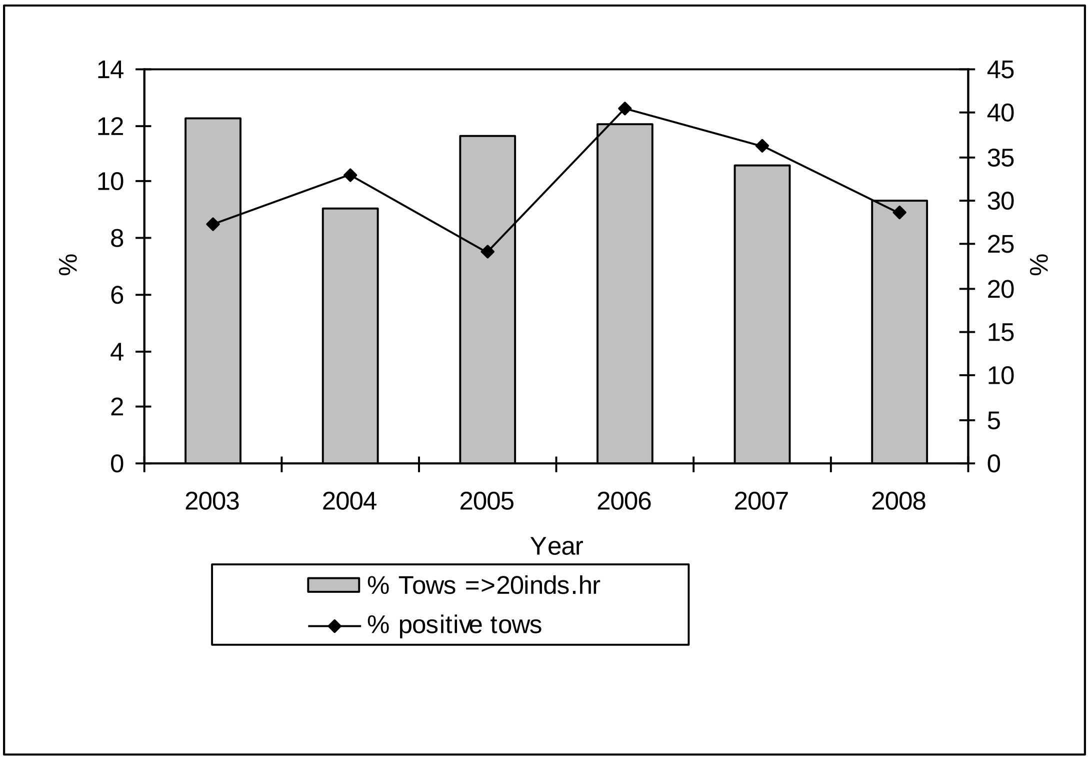


Figure 2.12. Northeast Atlantic spurdog. Proportion of survey hauls in Irish Q3 groundfish survey 2003–2008, ICES Area 7, in which nominal CPUE was ≥ 20 per one hour tow, and percentage of tows in which spurdog occurred.

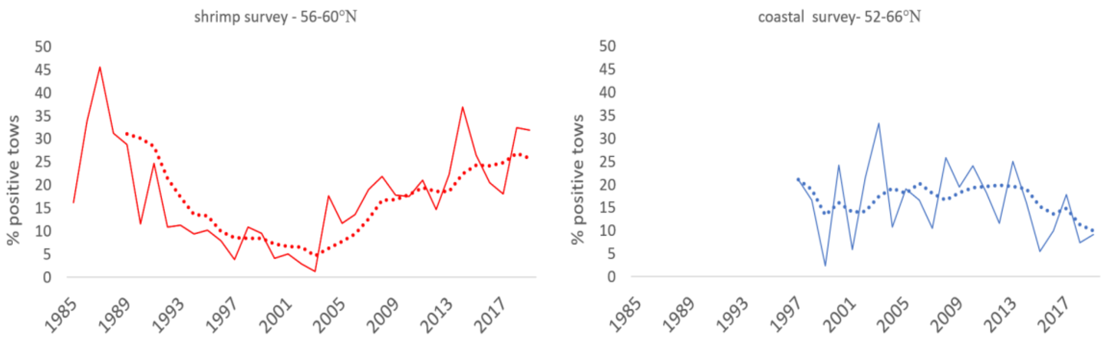


Figure 2.13. Northeast Atlantic spurdog. Percentage of tows in shrimp (left) and coastal (right) survey in which spurdog occurred by year, with moving average (dotted, 5 yrs).

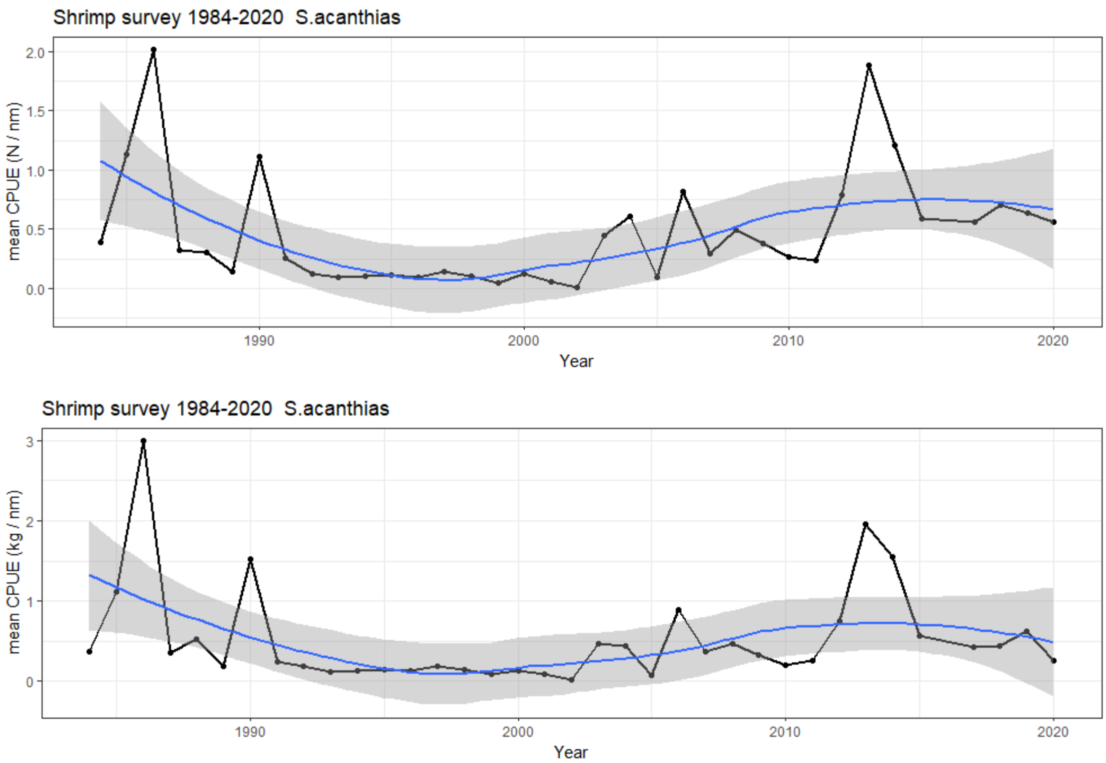


Figure 2.14. Northeast Atlantic spurdog. Mean CPUE for numbers per nm (top) and biomass per nm (bottom) by year with smooth for shrimp survey 1984–2020 (Junge *et al*. (2020 WD)).

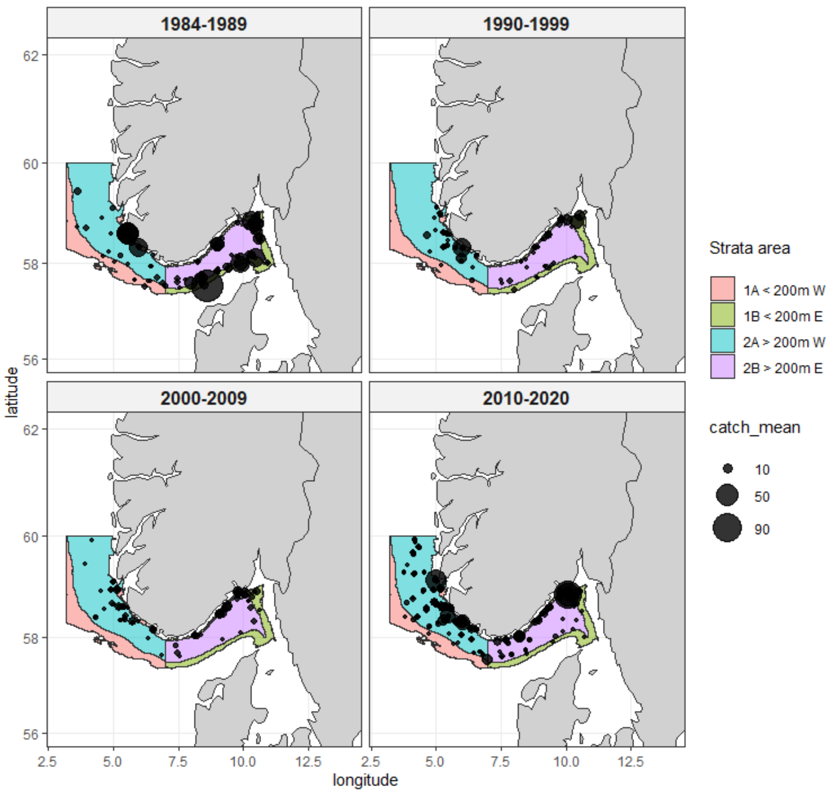
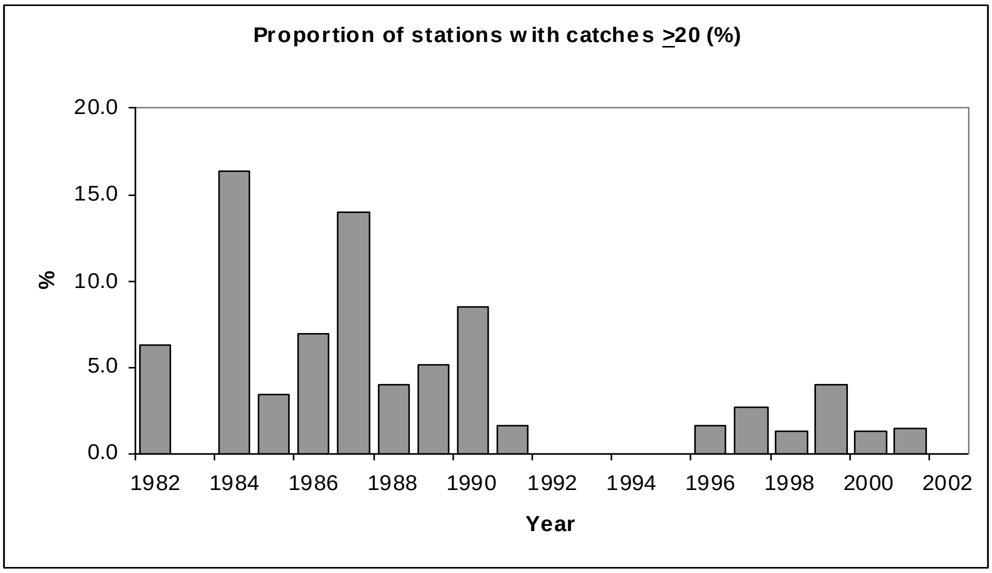


Figure 2.15. Northeast Atlantic spurdog. Mean catch numbers per strata by decade for shrimp survey 1984–2020 (Junge *et al*. (2020 WD)).



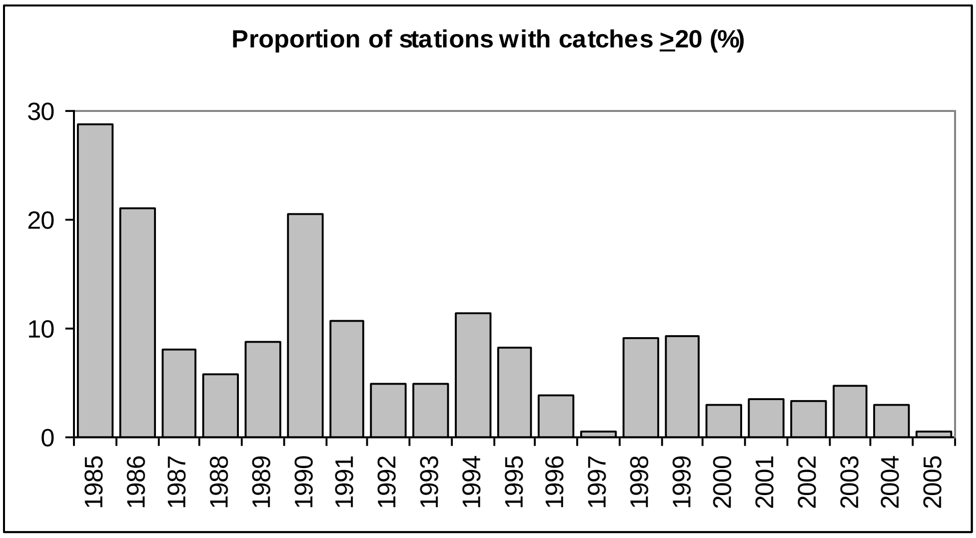
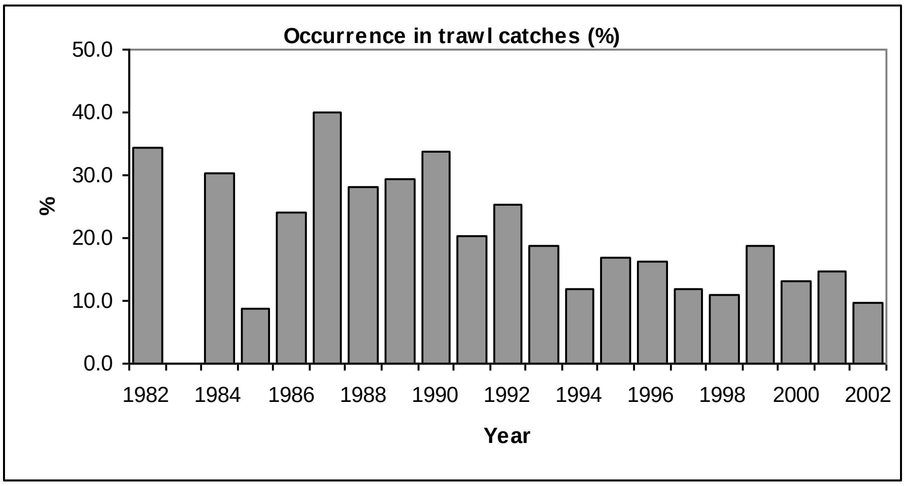


Figure 2.16. Northeast Atlantic spurdog. Proportion of survey hauls in the English Celtic Sea groundfish survey (1982–2002, top) and Scottish west coast (6.a) survey (Q1, 1985–2005, bottom) in which CPUE was ≥ 20 ind. h^{-1}. (Source: ICES, 2006).

a)



b)

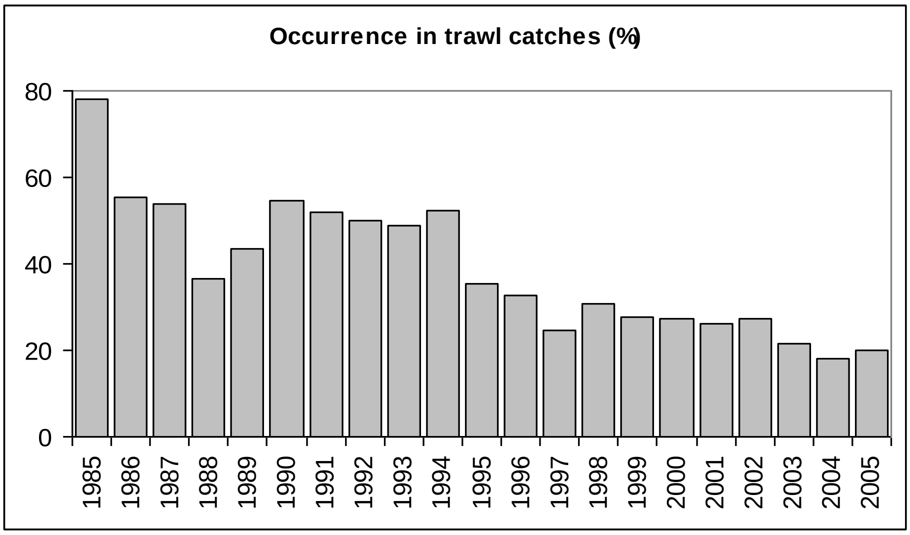


Figure 2.17. Northeast Atlantic spurdog. Frequency of occurrence in survey hauls in a) the English Q1 Celtic Sea groundfish survey (1982–2002), and b) the Scottish west coast (6.a) survey (Q1, 1985–2005).

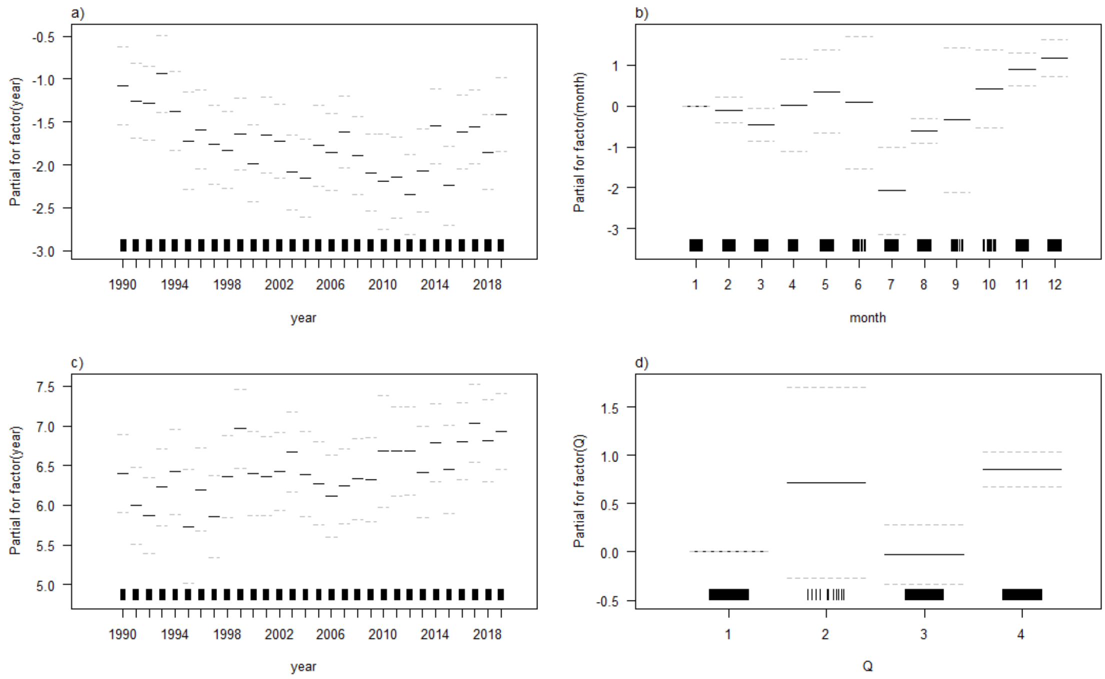


Figure 2.18. Northeast Atlantic spurdog. Estimated year and quarter effects (± 1 s.e.) from the delta-lognormal GLM: binomial model shown in a) and b), and lognormal results in c) and d) (log scale).

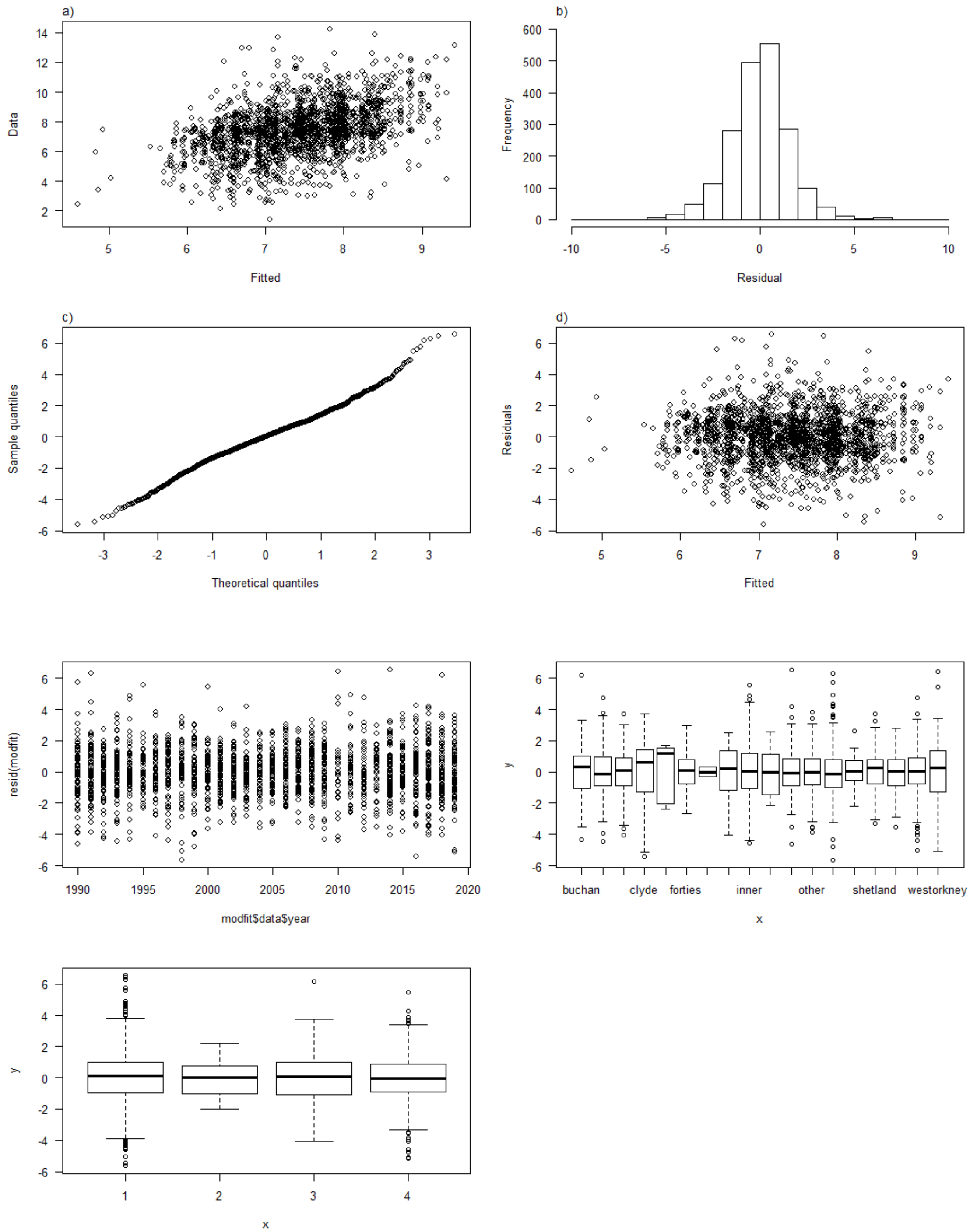


Figure 2.19. Northeast Atlantic spurdog. Analysis of Scottish survey data. Residual plot of final lognormal model fit: a) observed vs. fitted values, b) histogram of residuals, c) normal Q-Q plot, d) residuals vs. fitted values and e), f) and g) residuals vs. year, area and quarter.

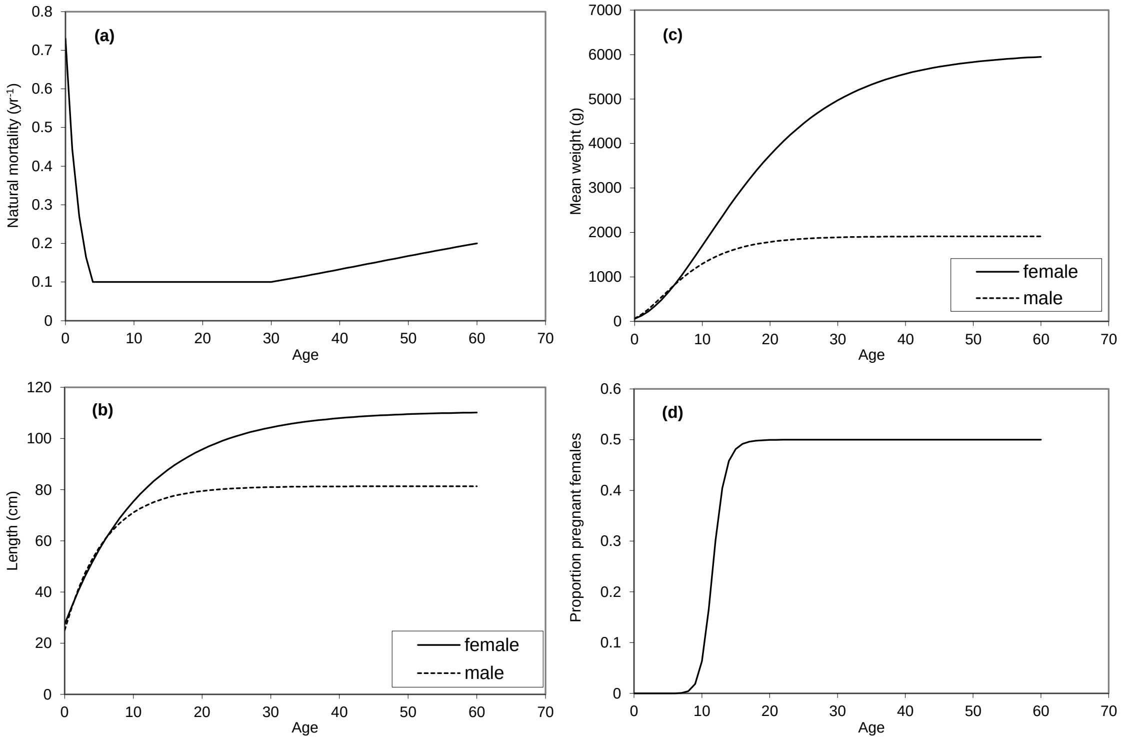


Figure 2.20. Northeast Atlantic spurdog. A visual representation of the life-history parameters described in Table 2.6. [Note, the value of natural mortality-at-age 0 is a parameter derived from the assessment.]

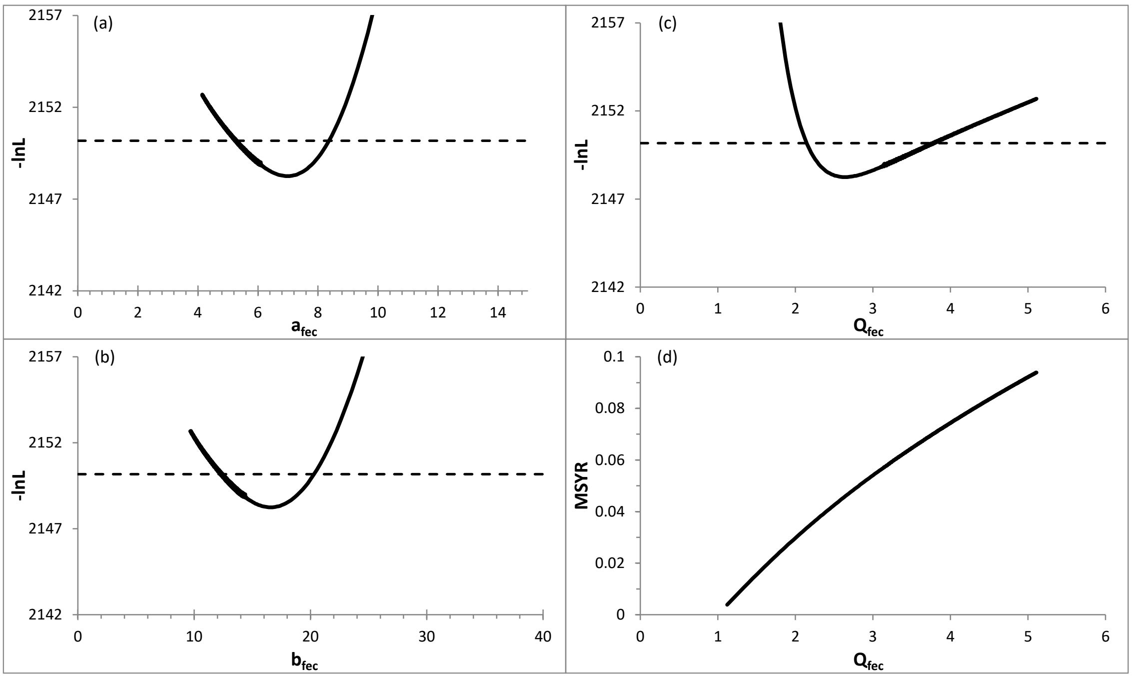


Figure 2.21. Northeast Atlantic spurdog. C_{SQ} assessment. Negative log-likelihood (-ln*L*) for a range of (a) a_{fec} and (b) b_{fec} values, with (c) corresponding Q_{fec}. Plot (d) shows MSYR (MSY/B_{MSY}) vs. Q_{fec}. Using the likelihood ratio criterion, the hashed line in plots (a)–(c) indicate the minimum –ln*L* value + 1.92, corresponding to 95% probability intervals for the corresponding parameters for values below the line.

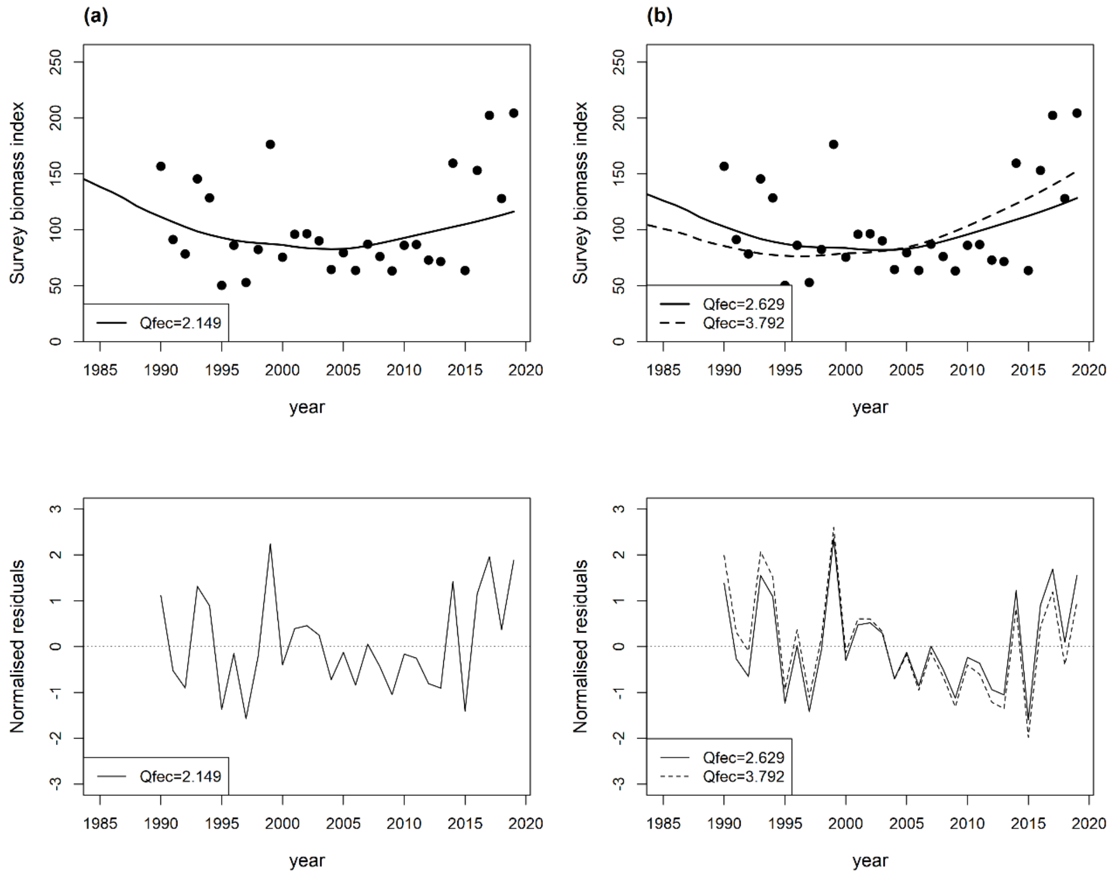


Figure 2.22. Northeast Atlantic spurdog. C_{SQ} assessment. Model fits to the Scottish surveys abundance index (top panel), with normalised residuals ($\varepsilon_{sur,y}$ in Stock Annex equation 9b) (bottom) for (a) the base-case Qfec = 2.000 (the more conservative lower bound in Figure 2.21c) and (b) for two alternatives (the optimum and upper bounds in Figure 2.21c) that fall within the 95% confidence bounds.

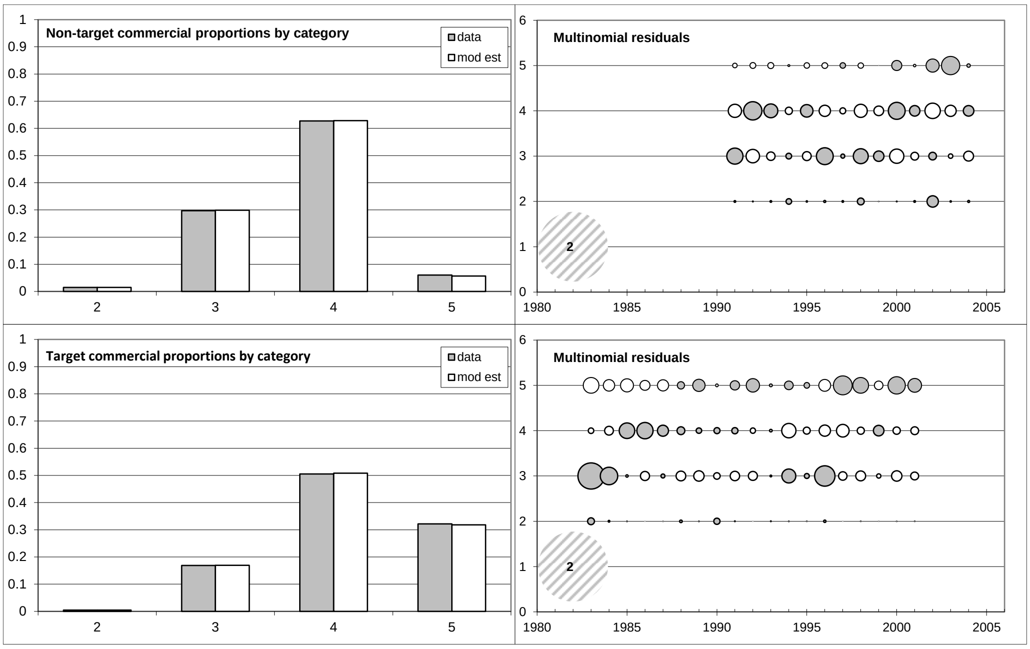


Figure 2.23a. Northeast Atlantic spurdog. C_{SQ} assessment. Model fits to the non-target (Scottish; top row) and target (England & Wales; bottom row) commercial proportions-by-length category data for the base case run. The left-hand side plots show proportions by length category averaged over the time period for which data are available, with the length category given along the horizontal axis. The right-hand side plots show multinomial residuals ($\varepsilon_{pcom,j,y,L}$ in Stock Annex equation 10b), with grey bubbles indicating positive residuals, bubble area being proportional to the size of the residual (the light-grey hashed bubble indicates a residual size of 2, and is shown for reference), and length category indicated on the vertical axis. The length categories considered are 2: 16–54 cm; 3: 55–69 cm; 4: 70–84 cm; 5: 85+ cm.

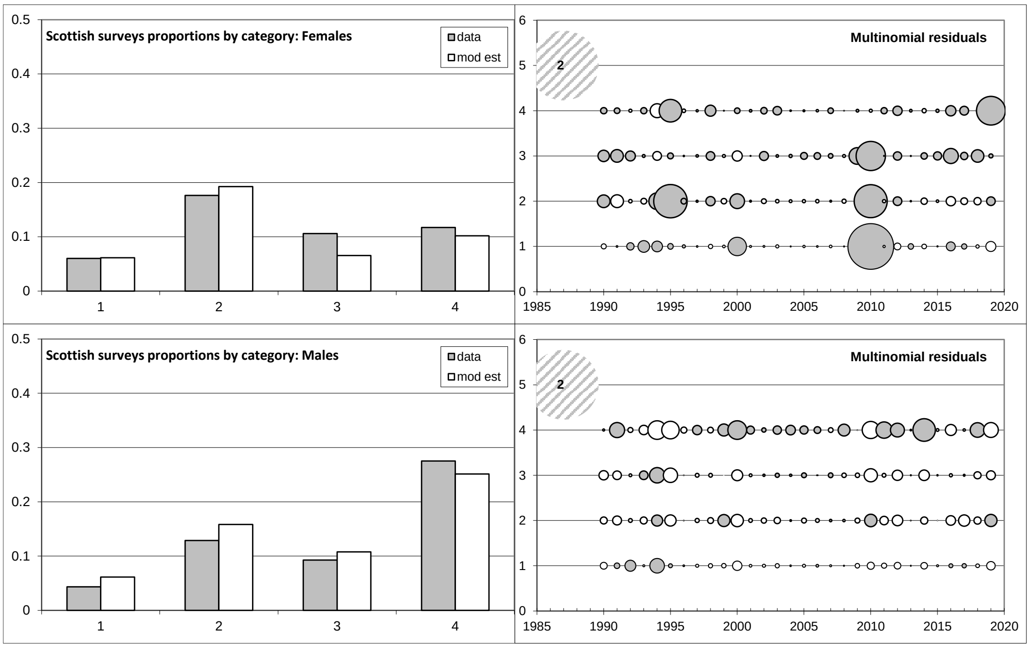


Figure 2.23b. Northeast Atlantic spurdog. C_{SQ} assessment. Model fits to the Scottish survey proportions-by-length category data for the base-case run for females (top row) and males (bottom row). A further description of these plots can be found in the caption to Figure 2.23a. Length categories considered are 1: 16–31 cm; 2: 32–54 cm; 3: 55–69 cm; 4: 70+ cm.

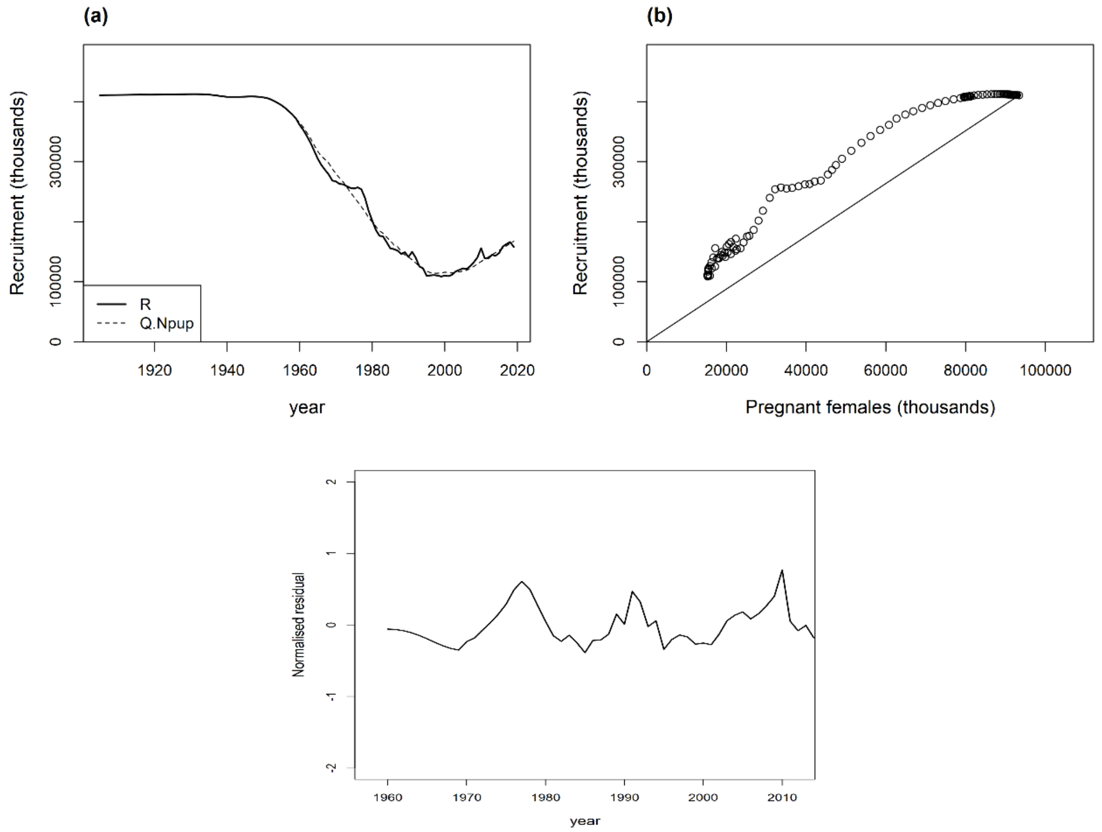


Figure 2.24. Northeast Atlantic spurdog. C_{SQ} assessment. (a) A comparison of the deterministic (N_{pup}) and stochastic (R) versions of recruitment (Stock Annex equations 2a–c) (top-left panel) with normalised residuals ($\varepsilon_{r,y}/\varepsilon_r$, where $\varepsilon_{r,y}$ are estimable parameters of the model) (bottom); and (b) a plot of recruitment (R) vs. number of pregnant females (in thousands; open circles), together with the replacement line (number of recruiting pups needed to replace the pregnant female population under no harvesting).

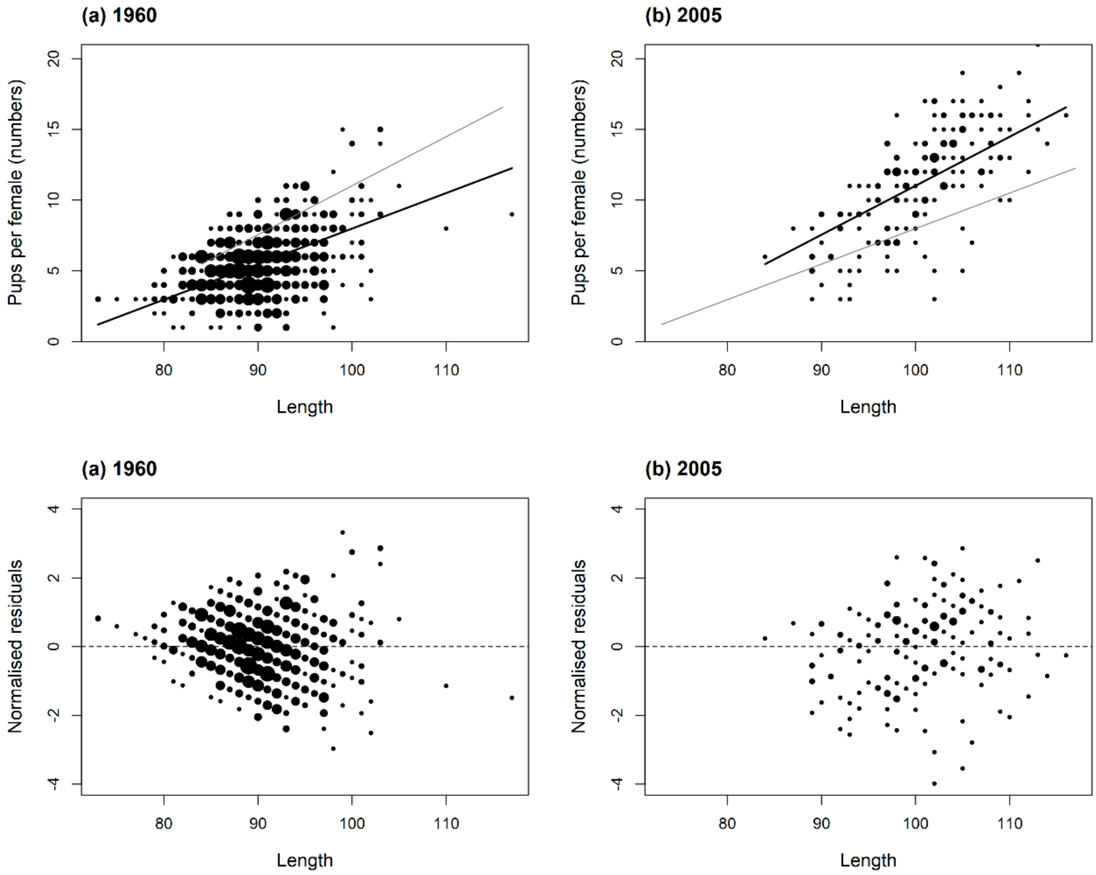


Figure 2.25. Northeast Atlantic spurdog. C_{SQ} assessment. Fit to fecundity data from two periods (top row) (a) 1960 and (b) 2005, with associated normalised residuals ($\varepsilon_{fec,k,y}$ in Stock Annex equation 11b) (bottom row). For the top plots, the heavy black lines reflect the model estimates for the given points, while the light grey ones, reflecting the model estimates for the points in the adjacent plot, are given for comparison. For all plots, the diameter of each point is proportional to $\sqrt{n}$, where *n* is the number of samples with the same number of pups for a given length.

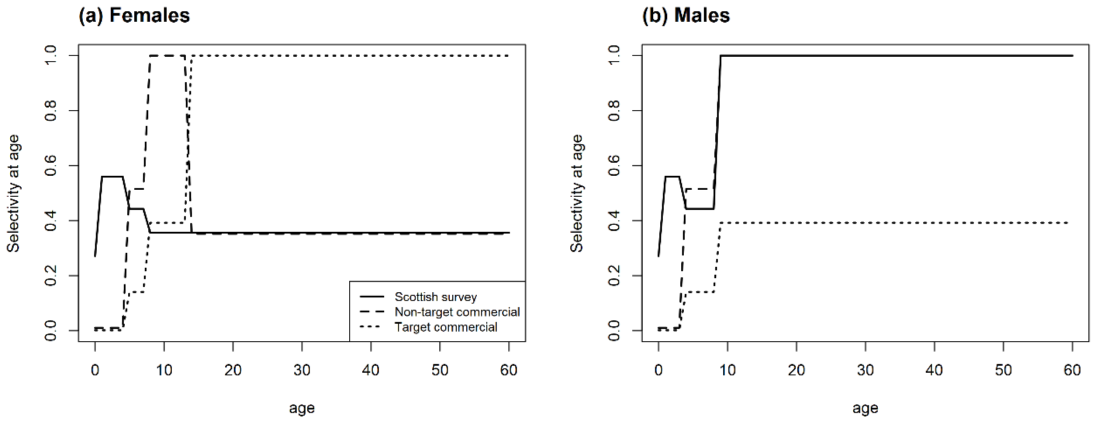


Figure 2.26. Northeast Atlantic spurdog. C_{SQ} assessment. Estimated selectivity-at-age curves for the base case run for (a) females and (b) males. The two commercial fleets considered have non-target (Scottish) and target (England & Wales) selectivity, which differ by sex because of the life-history parameters for males and females (Table 2.6). The survey selectivity relies on Scottish survey data.

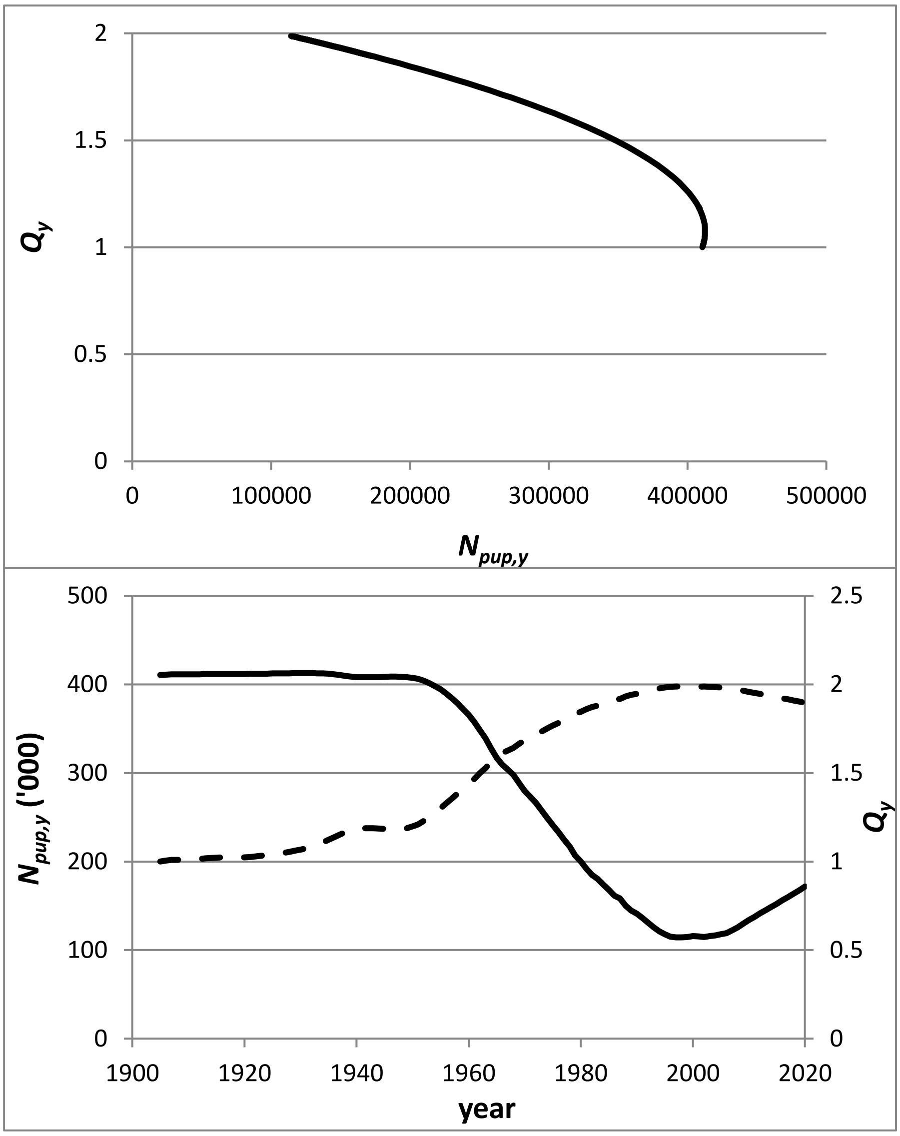


Figure 2.27. Northeast Atlantic spurdog. C_{SQ} assessment. A plot of the density-dependent factor Q_y (Stock Annex equation 2b) against the number of pups $N_{pup,y}$ (top; in thousands), and both plotted against time (bottom; solid line for $N_{pup,y}$, and hashed line for Q_y).

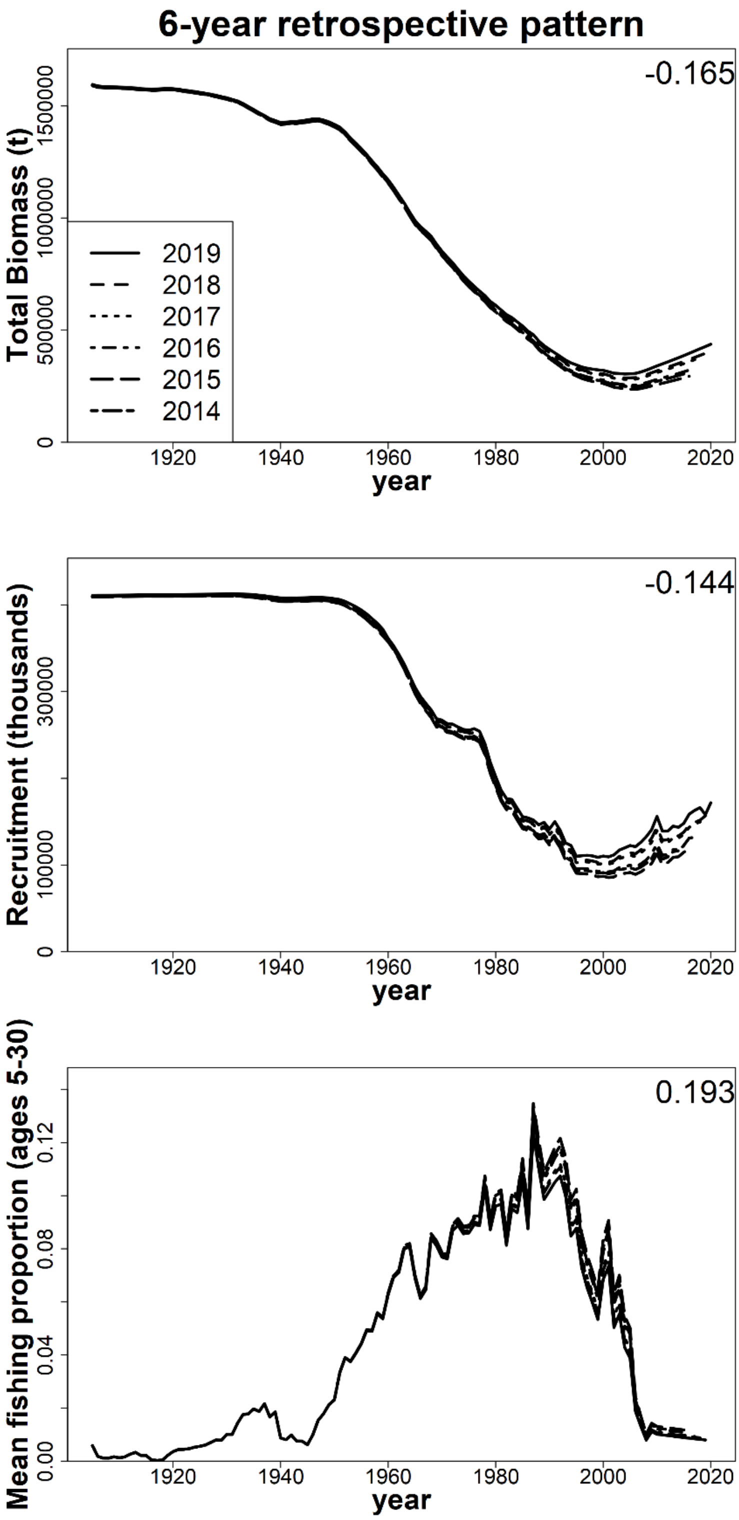


Figure 2.28. Northeast Atlantic spurdog. C_{SQ} assessment. Six-year retrospective plots (omitting probability intervals for clarity; the model was re-run, each time omitting a further year in the data). Mohn's rho is given in the top-right of each plot.

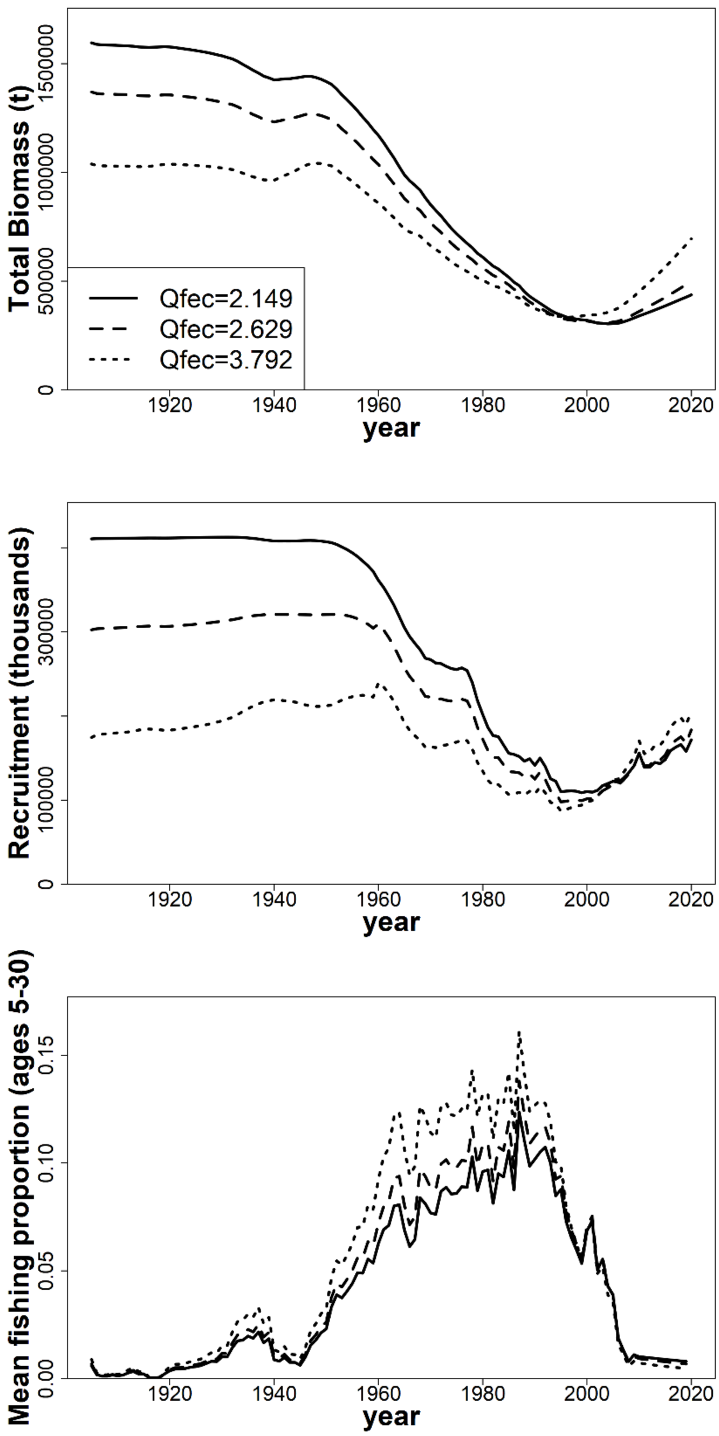


Figure 2.29. Northeast Atlantic spurdog. C_{SQ} assessment. A sensitivity analysis of the parameter that determines the extent of density-dependence in pup production (Q_{fec}). Three alternative values are considered, related to the smallest, optimum (in terms of lowest –ln*L*) and largest value of Q_{fec} below the hashed line in Figure 2.21c (respectively 2.149 [base case], 2.629 and 3.792).

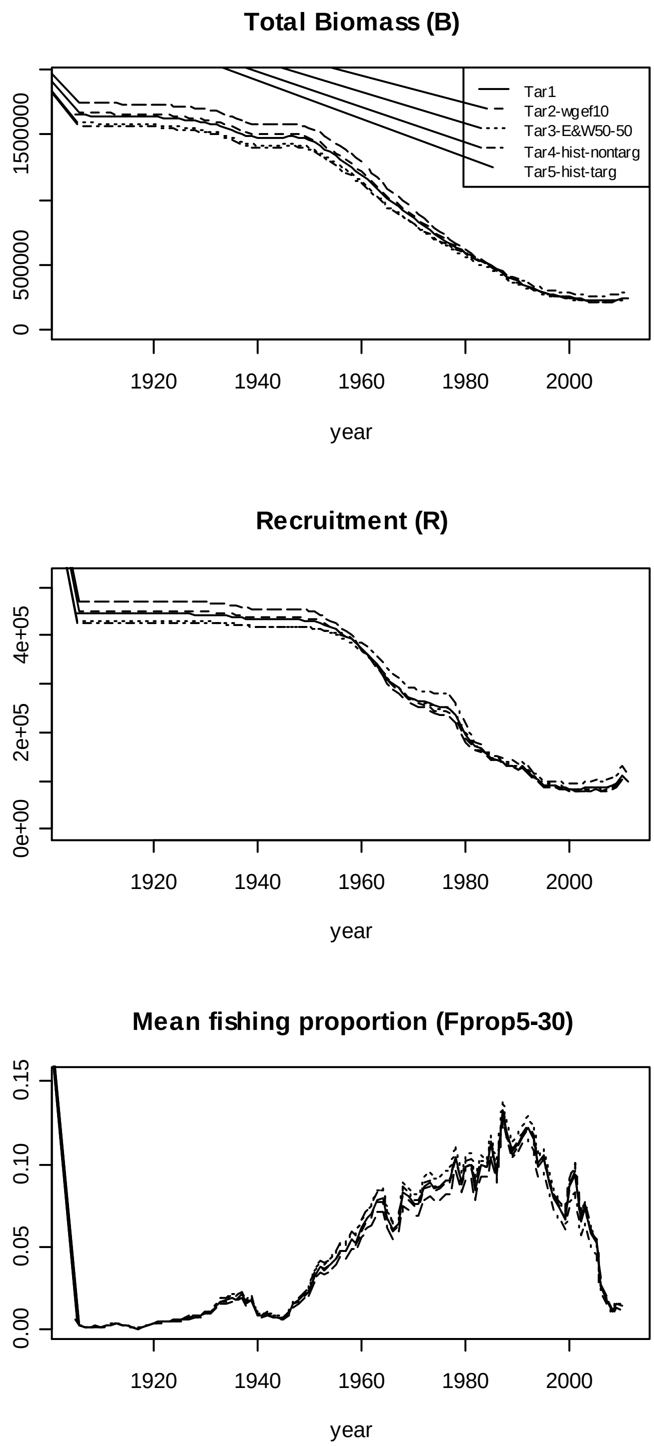


Figure 2.30. Northeast Atlantic spurdog. A comparison of the alternative targeting scenarios, where fishing is defined as either "non-target" (Scottish selectivity) or "target" (England & Wales selectivity). Tar 1 is the base case (each nation is defined "non-target", "target" or a mixture of these, with pre-1980s allocated the average for 1980–1984), Tar 2 is as for WGEF in 2010 (Scottish landings are "non-target", E&W "target", and the remainder raised in proportion to the Scottish/E&W landings, with pre-1980s allocated the average for 1980–1984), Tar 3 as for Tar 2 but with E&W split 50% "non-target" and 50% "target", and Tar 4 and 5 as for Tar 1, but with pre-1980 selectivity entirely non-target (former) or target (latter). This figure is taken from WGEF (2011; i.e. not updated with subsequent data) to illustrate sensitivity to assumptions about historic selection.

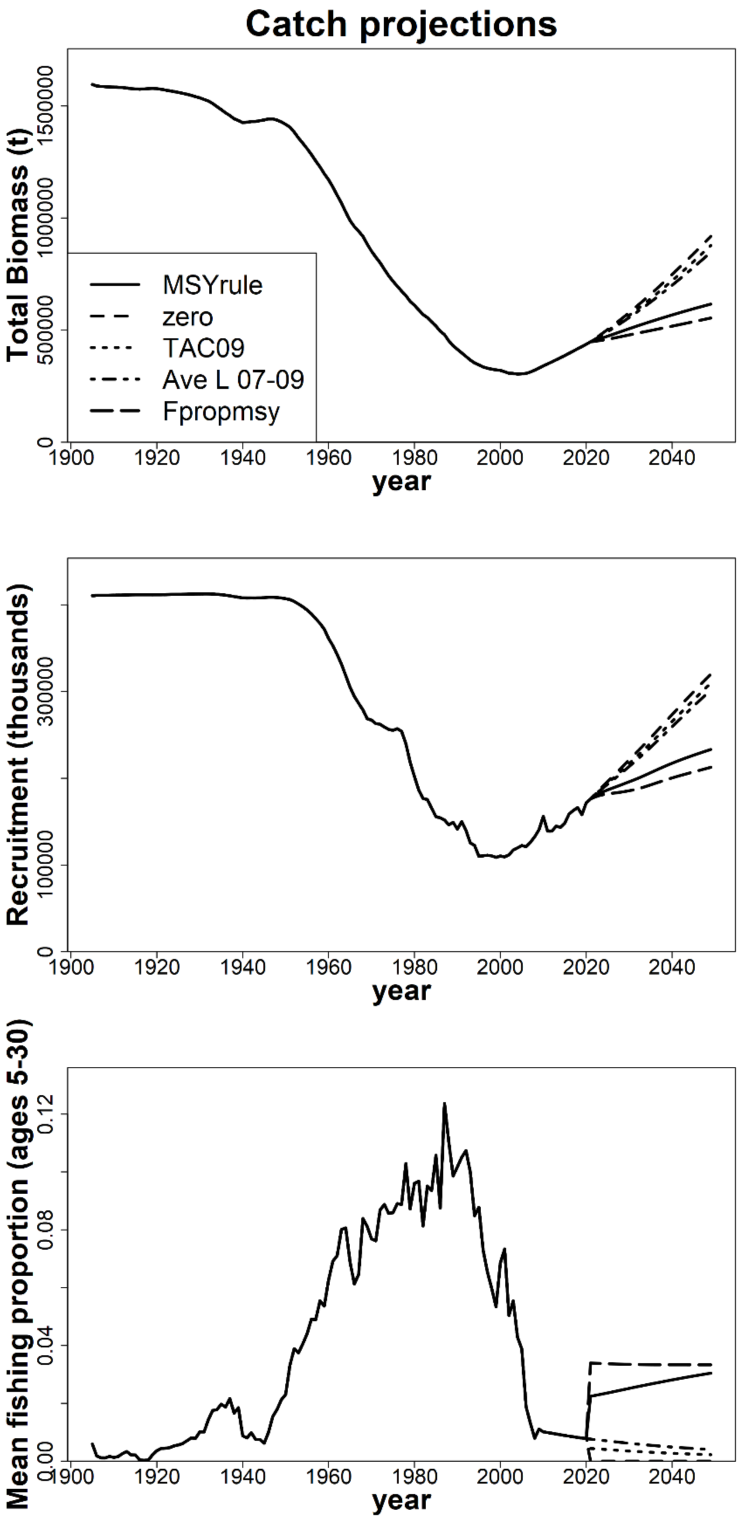


Figure 2.31. Northeast Atlantic spurdog. C_{SQ} assessment. 30-year projections for different levels of future catch, including zero catch for reference.

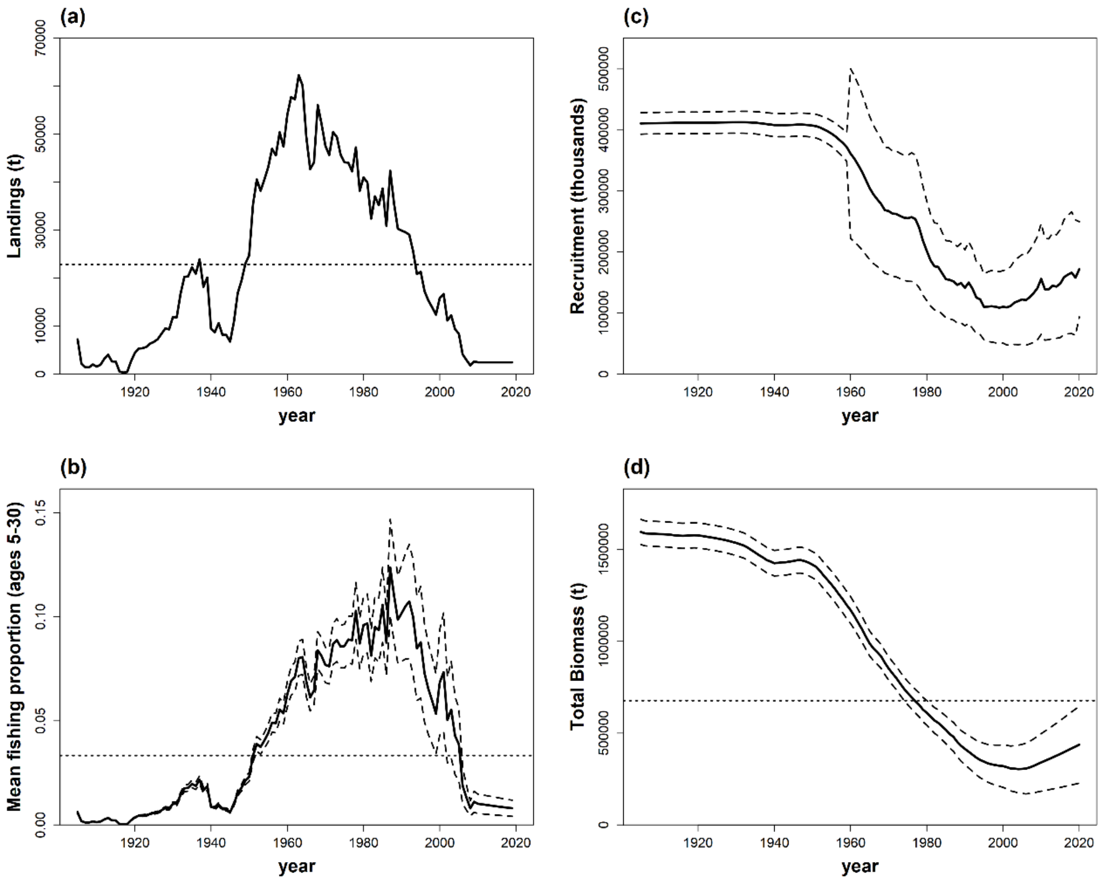


Figure 2.32. Northeast Atlantic spurdog. C_{SQ} assessment. Summary four-plot for the base-case, showing long-term trends in landings (tons; dotted horizontal line = *MSY* = 22 847 t), recruitment (thousands of pups), mean fishing proportion (average ages 5–30; dotted horizontal line = $F_{prop,MSY}$ = 0.033) and total biomass (tons; dotted horizontal line = *MSY* $B_{trigger}$ = 677 068 t). Hashed lines reflect estimates of precision (±2 standard deviations).

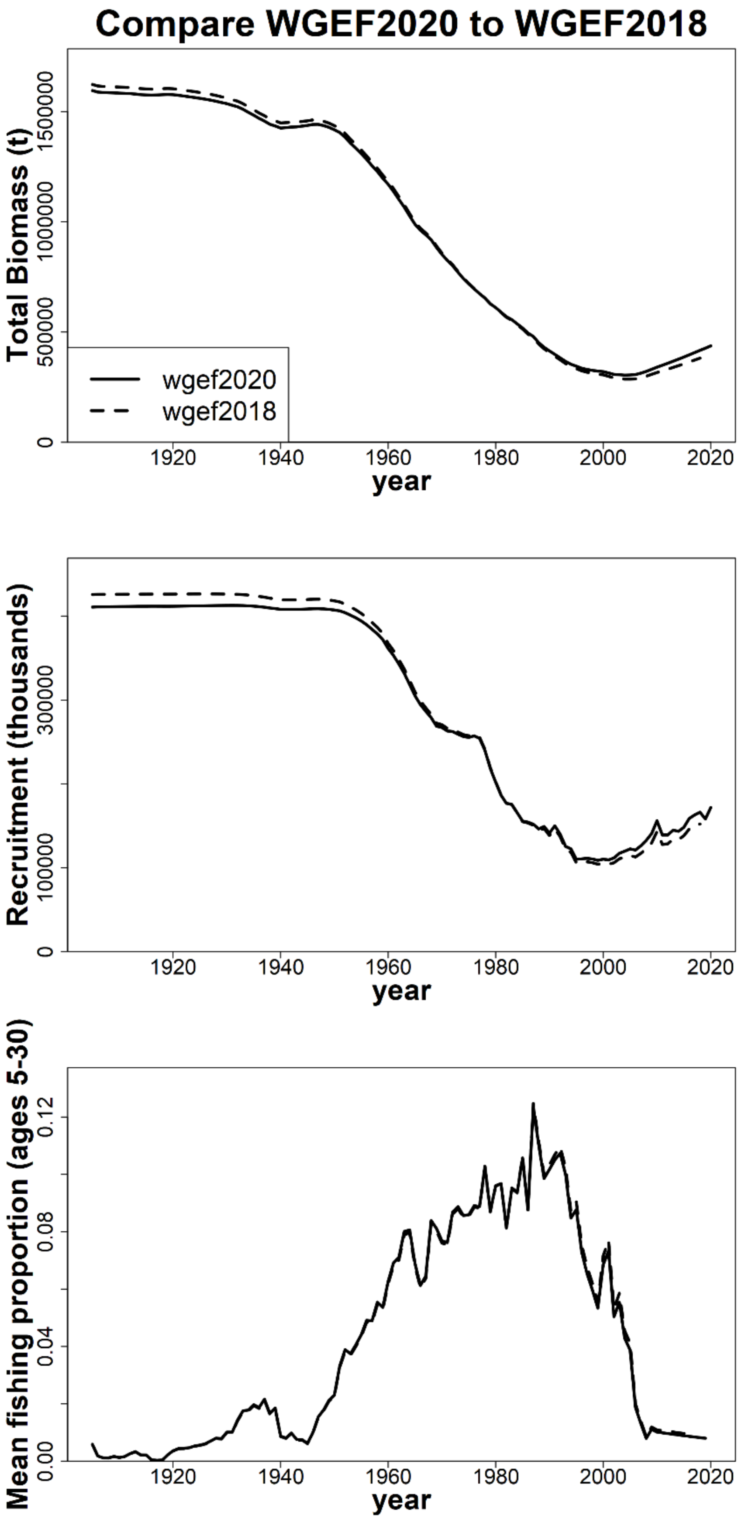


Figure 2.33. Northeast Atlantic spurdog. C_{SQ} assessment. Comparison with the assessment from WGEF (2018).

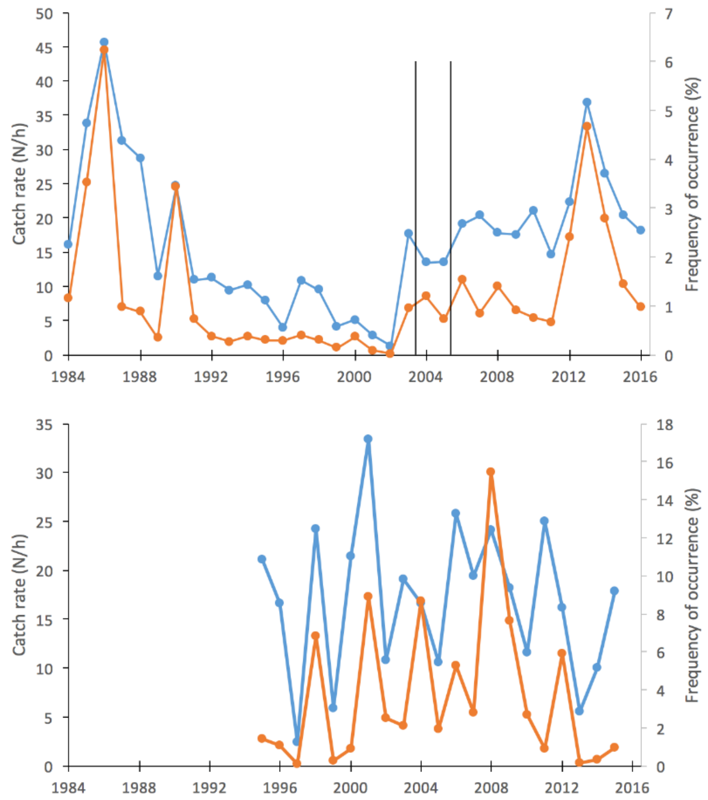


Figure 2.34. Northeast Atlantic spurdog. Survey indices of spurdog in terms of catch rates (orange lines) and frequency of occurrence (blue lines) from the Norwegian Shrimp Survey in South-Norway (top panel) and the Norwegian Coastal Survey in North-Norway (bottom panel). The two vertical lines indicate changes in seasonal coverage of the shrimp survey, being in fourth quarter from 1984, in second quarter from 2004, and in first quarter from 2006.

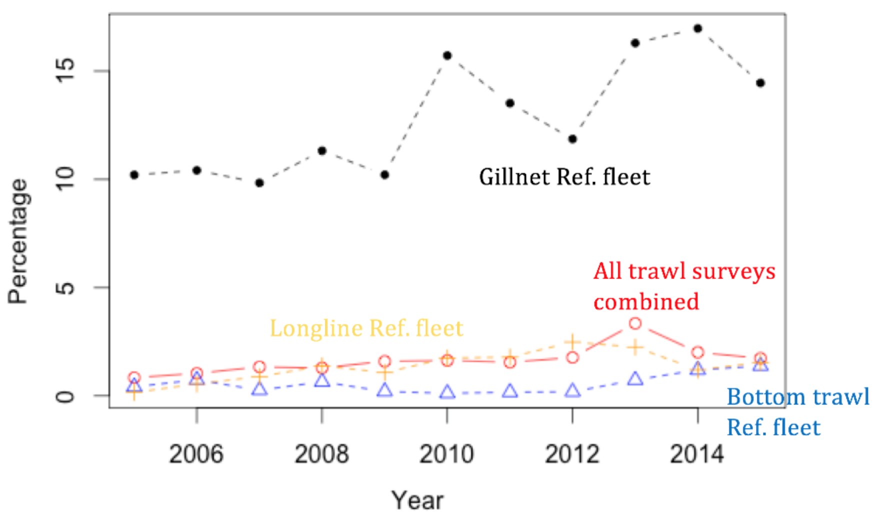


Figure 2.35. Northeast Atlantic spurdog. Percentage occurrence of spurdog in sampled Norwegian commercial catches from each year and from each major fishery groups.

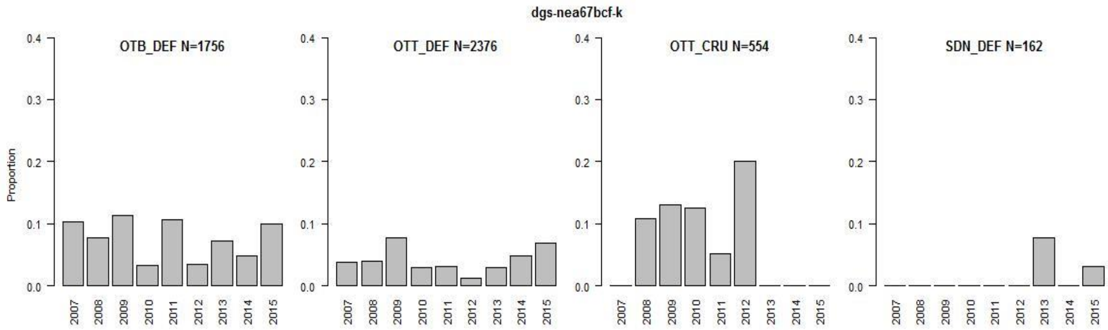


Figure 2.36. Northeast Atlantic spurdog. Proportion of commercial hauls encountering spurdog in French fisheries (main level 5 métiers catching spurdog) in Subarea 6 and divisions 7.b–c and 7.f–k for the period 2007–2015. N: total number of fishing operations sampled for the métier.

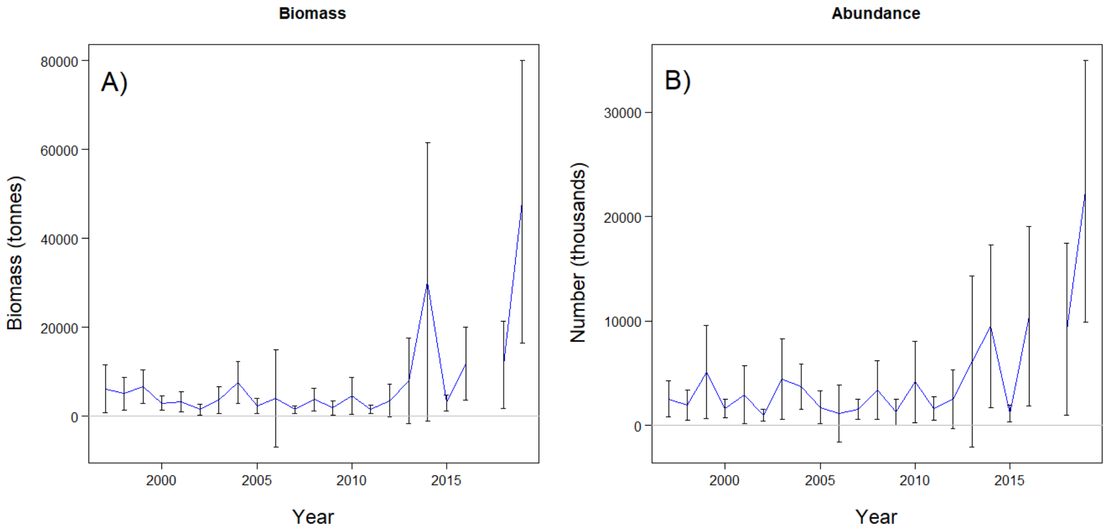


Figure 2.37. Swept area biomass and abundance index of spurdog in the EVHOE (EVHOE-WIBTS-Q4) survey.

3 Deep-water sharks; leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (subareas 4–14)

3.1 Stock distribution

A number of species of deep-water sharks have been exploited in the ICES area. This section deals with leafscale gulper shark *Centrophorus squamosus* and Portuguese dogfish *Centroscymnus coelolepis*, which have been the two species of greatest importance to commercial fisheries.

In the past in some of European fisheries, landings data for the two species were combined for most of the period since the beginning of the fishery, under a generic term "siki".

3.1.1 Leafscale gulper shark

The leafscale gulper shark has a wide distribution in the Northeast (NE) Atlantic, from Iceland and Atlantic slopes south to Senegal, Madeira and the Canary Islands. On the Mid-Atlantic Ridge, it is distributed from Iceland to the Azores (Hareide and Garnes, 2001). The species can be demersal on the continental slopes (at depths of 230–2400 m) or have a more pelagic behaviour, occurring in the upper 1250 m of oceanic areas with seafloor around 4000 m (Compagno and Niem, 1998).

Available information suggests that this species is highly migratory (Clarke *et al.*, 2001; 2002; Moura *et al.*, 2014; Rodríguez-Cabello *et al.*, 2016). In the NE Atlantic, the distribution pattern formerly assumed considered the existence of a large-scale migration, where females would give birth off the Madeira Archipelago, as there were reports of pregnant females (Severino *et al.*, 2009) in that region. Geo-referenced data show that pregnant females also occur off Iceland, indicating another potentially important reproductive area in the northern part of the NE Atlantic (Moura *et al.*, 2014). Juveniles are only caught rarely. Segregation by sex, size and maturity seems to occur, likely linked to factors such as depth and temperature. Post-natal and mature females tend to occur in relatively shallower sites. Pregnant females are distributed in warmer waters compared to the remaining maturity stages, particularly immature females, which are usually found at greater depths and lower temperatures (Moura *et al.*, 2014). Although based on a small sample size, tagging studies have observed movements from the Cantabrian Sea to the Porcupine Bank (Rodríguez-Cabello and Sánchez, 2014; Rodríguez-Cabello *et al.*, 2016) and north to the Faroes Islands (Rodríguez-Cabello, personal comm.).

Results from a molecular study, using six nuclear loci, did not reject the null hypothesis of genetic homogeneity among NE Atlantic samples (Verissimo *et al.*, 2012). The same study showed that females are less dispersive than males and possibly philopatric. In the absence of clearer information on stock identity, a single assessment unit of the Northeast Atlantic has been adopted.

3.1.2 Portuguese dogfish

The Portuguese dogfish is distributed widely in the NE Atlantic. Stock structure and spatial dynamics are poorly understood. Specimens below 70 cm have been recorded rarely. The absence of small fishes in the NE Atlantic may be a consequence of their concentration in nurseries outside the sampling areas, movement to pelagic or deeper waters, gear selectivity or to different habitat and/or prey choices, with juveniles being more benthic (Moura *et al.*, 2014). Consistent results among different studies show that females move to shallower waters for parturition (Girard and Du Buit, 1999; Clarke *et al*., 2001; Moura and Figueiredo, 2012 WD; Moura *et al*., 2014). Similar size ranges and different maturity stages exist in both the northern and southern European continental slopes. The occurrence of all adult reproductive stages within the same geographical area and, in many cases in similar proportions among different areas, suggests that this species is able to complete its life cycle within these areas (Moura *et al*., 2014).

Population structure studies developed so far using microsatellites and mitochondrial DNA show no evidence of genetic population structure among collections in the NE Atlantic (Moura *et al*., 2008 WD; Verissimo *et al*., 2011; Catarino *et al*., 2015). In the absence of clearer information on stock identity, a single assessment unit of the Northeast Atlantic has been adopted.

3.2 The fishery

3.2.1 History of the fishery

Fisheries taking leafscale gulper shark or Portuguese dogfish are described in their respective stock annexes.

Since 2010, EU TACs for deep-water sharks have been set at zero. Consequently, reported landings for each of the two species since then were very low or zero.

In 2016, the EU fixed, for 2017 and 2018, a restrictive by-catch allowance, permitting limited landings of unavoidable by-catches of deep-sea sharks in directed artisanal deep-sea longline fisheries for black scabbardfish (Council regulation (EU) 2016/2285). Specifically, 10 tonnes were allowed for deep-sea sharks in Union and international waters of ICES subareas 5, 6, 7, 8 and 9, in Union and international waters of ICES Subarea 10 and in Union waters of CECAF 34.1.1, 34.1.2 and 34. 2. For 2019 and 2020, the allowed by-catch was established as 7 tonnes for each of these areas (Council regulation (EU) 2018/2025). Landings of deep-water sharks were prohibited in 2021, with no by-catch allowance. Discards are known to occur but were not quantified.

3.2.2 Species distribution and spatial overlap with fisheries

During 2011–2012, the project “Reduction of deep-sea sharks bycatches in the Portuguese longline black scabbard fishery” (Ref. MARE C3/IG/re ARES (2011) 1021013) was carried out to study the bycatch of deep-water sharks, mainly leafscale gulper shark and Portuguese dogfish, in the Portuguese longline fisheries targeting black scabbardfish (mainland Portugal, Azores and Madeira). The main objectives of this Project were to evaluate: i) the species distributions; ii) the spatial overlap between deep-sea sharks and black scabbardfish; and iii) the efficiency on deep-water shark by-catch under modifications of the fishing gear.

WGEF considers that this study does not provide sufficiently detailed information on the distribution of deep-water shark species and on their stocks’ status, as it was restricted to the reduced fishing areas exploited by deep-water longline fisheries targeting black scabbardfish. The data and the low sampling levels were considered insufficient to provide the spatial coverage to allow the evaluation of the spatial overlap between deep-sea sharks and black scabbardfish. Biomass indices were derived from a combination of quite distinct data sources, including logbooks and on-board observations. Each of these two data sources have substantial caveats and their combination have been done without taking these into consideration. As a consequence, the results should be scrutinized with caution; for instance, the trends presented in the report were not clearly supported by data and information available. No technical modifications introduced to minimize the deep-sea sharks bycatch levels on the fishing gear were evaluated.

Geostatistical studies (Veiga *et al*., 2013; Veiga *et al*., 2015 WD) using deep-water longline black scabbardfish fishery data (vessel monitoring systems, logbooks and official daily landings) were conducted with the aim of evaluating the spatial distribution and spatial overlap between i) black scabbardfish and leafscale gulper shark and between ii) black scabbardfish and Portuguese dogfish taken by the longline fishery operating off mainland Portugal (Division 9.a). Results obtained indicated that in fishing grounds where black scabbardfish is more abundant and where fishing takes place, the relative occurrence of both deep-water shark species was reduced. These differences on the relative occurrence have implications for alternative management measures to be adopted in the deep-water longline black scabbardfish fishery, particularly in what concerns the minimization of deep-water shark bycatch. The existence of differences in the deep-water sharks' abundance between fishing grounds for black scabbardfish and deeper fishing grounds was further supported by results from a short-duration pilot survey on board commercial fishing vessels belonging the Portuguese mainland black scabbard fishery in 2014 (Veiga, 2015 WD). Under this survey, ten fishing hauls were performed by 5 vessels, each vessel performing one haul at the fishing grounds exploited by the black scabbardfish fleet (BSF fishing grounds) and other located at deeper areas adjacent to these fishing grounds. For all vessels, the proportions of each shark species (~ quotient between the caught weight of the deep-water shark under analysis and the sum of the caught weight of black scabbardfish and of that deep-water shark) was significantly smaller in hauls performed at the BSF fishing grounds and those located deeper (Table 3.4).

In addition to the conclusions drawn by these studies, a recent analysis of onboard data collected at commercial vessels belonging to the Portuguese deep-water longline fishery that takes place in ICES Subarea 9 suggests that *C. squamosus* and *D. calceus* have a higher spatial overlap with the fishery for black scabbardfish than *C. coelolepis* (Figueiredo and Moura, 2019 WD). Worth to mention that *C. squamosus* and *D. calceus* have a widespread distribution and undertake migrations associated to reproduction (despite those from the *D. calceus* being less understood).

As a reaction of the restrictive EU management measures adopted for deep-water sharks, fishing vessels also tend to avoid fishing grounds where deep-water sharks are more likely to be caught. No survival of sharks when returned to the sea is expected. The only evidence of survival of deep-water sharks after longline catch was reported for leafscale gulper sharks following a Spanish scientific tagging survey. The survey used deep-water longlines, which were laid at depths ranging from 900 to 1100 m (Rodríguez-Cabello and Sánchez, 2014; 2017). In that study, the soaking time was restricted to 2–3 hours and the lines were hauled back at a speed of 0.4–0.5 m s^{-1}. It is important to note that these fishing practices are different from those used by commercial vessels.

3.2.3 The fishery in 2020

No new information.

3.2.4 ICES advice applicable

Leafscale gulper shark: in 2019, ICES advised that "*when the precautionary approach is applied there should be zero catches in each of the years 2020–2023.*".

Portuguese dogfish: in 2019, ICES advised that "*when the precautionary approach is applied there should be zero catches in each of the years 2020–2023.*".

3.2.5 Management applicable

The EU TACs that have been adopted for deep-sea sharks in European Community waters and international waters for different ICES subareas are summarized below.

Year	ICES subareas		
	5–9	**10**	**12 (includes also *Deania histricosa*[5] and *Deania profondorum*)**
2005 and 2006	6763	14	243
2007	2472[1]	20	99
2008	1646[1]	20	49
2009	824[1]	10[1]	25[1]
2010	0[2]	0[2]	0[2]
2011	0[3]	0[3]	0[3]
2012	0	0	0
2013	0	0	0
2014	0	0	0
2015	0	0	0
2016	0	0	0
2017	10[4]	10[4]	0
2018	10[4]	10[4]	0
2019	7[4]	7[4]	0
2020	7[4]	7[4]	0
2021	---	---	---

(1) Bycatch only. No directed fisheries for deep-sea sharks are permitted.

(2) Bycatch of up to 10% of 2009 quotas is permitted.

(3) Bycatch of up to 3% of 2009 quotas is permitted.

(4) Exclusively for bycatch in longline fishery targeting black scabbardfish. No directed fishery shall be permitted.

(4) Recent studies demonstrated that there is not enough scientific support to discriminate *Deania hystricosa* from its congener *Deania calceus*; they are likely the same species (Rodríguez-Cabello *et al.*, 2020; Stefanni *et al.*, 2021)

Since 2013, the deep-sea shark category includes the following species (Council regulation (EC) No 1182/2013): Deep-water catsharks *Apristurus spp*., frilled shark *Chlamydoselachus anguineus*, gulper sharks *Centrophorus spp*., Portuguese dogfish *Centroscymnus coelolepis*, longnose velvet dogfish *Centroscymnus crepidater*, black dogfish *Centroscyllium fabricii*; birdbeak dogfish *Deania calceus*; kitefin shark *Dalatias licha*; greater lantern shark *Etmopterus princeps*; velvet belly *Etmopterus spinax*; mouse catshark *Galeus murinus*; six-gilled shark *Hexanchus griseus*; sailfin roughshark *Oxynotus paradoxus*; knifetooth dogfish *Scymnodon ringens* and Greenland shark *Somniosus microcephalus*.

Since 2015, the leafscale gulper shark and the Portuguese dogfish, have been included on the EU prohibited species list for Union waters of Division 2.a and Subarea 4 and in all waters of Subareas 1 and 14 (Council Regulation (EC) No 2015/104, Art. 12:1(g)).

Since 2013, under NEAFC Recommendation, 7 it was required that Contracting Parties prohibit vessels flying their flag in the Regulatory Area from directed fishing for deep-sea sharks on the following list: *Centrophorus granulosus, Centrophorus squamosus, Centroscyllium fabricii, Centroscymnus coelolepis, Centroscymnus crepidater, Dalatias licha, Etmopterus princeps, Apristurus spp, Chlamydoselachus anguineus, Deania calceus, Galeus melastomus, Galeus murinus, Hexanchus griseus, Etmopterus spinax, Oxynotus paradoxus, Scymnodon ringens* and *Somniosus microcephalus*.

In 2005, the use of trawls and gillnets in waters deeper than 200 m in the Azores, Madeira and Canary Island areas was banned (Council Regulation (EC) No 1568/2005). In 2007, the use of gillnets by Community vessels at depths greater than 600 m in ICES divisions 6.a-b, 7.b-c, 7.j-k and Subarea 12 was banned while a maximum bycatch of deep-water shark of 5% in hake and monkfish gillnet catches was allowed (Council Regulation (EC) No 41/2007). Since 2009, the "rasco (gillnet)" fishing gear was banned at waters deeper than the 600 m isobath (EC Regulation 43/2009). A gillnet ban in waters deeper than 200 m is also in operation in the NEAFC regulatory Area (all international waters of the ICES Area). NEAFC also ordered the removal of all such nets from NEAFC waters by 1 February 2006.

Since 2016, and in order to mitigate the potential damaging impacts of bottom trawling, fishing with bottom trawls was ban at depths deeper than 800 metres (EU Regulation 2016/2336).

A bycatch TAC for deep-water sharks was allowed for each of the years from 2017 to 2020, on a trial basis, in the directed artisanal deep-sea longline fisheries for black scabbardfish (Council regulation (EU) 2016/2285; Council regulation (EU) 2018/2025). According to this limited landing of unavoidable by-catches of deep-sea sharks were allowed and Member States should develop regional management measures for the black scabbardfish fishery and establish specific data-collection measures for deep-sea sharks to ensure their close monitoring. Specifically, 10 and 7 tonnes were allowed for deep-sea sharks in Union and international waters of ICES subareas 5, 6, 7, 8 and 9, in Union and international waters of ICES Subarea 10 and in Union waters of CECAF 34.1.1, 34.1.2 and 34. 2 in 2017–2018 and 2019–2020, respectively. This allowance was in accordance with ICES indications according to which in the artisanal deep-sea longline fisheries for black scabbardfish, the restrictive catch limits lead to misreporting of unavoidable by-catches of deep-sea sharks, which are currently discarded dead.

The Council regulation (EU) 2016/2285 affects specifically the Portuguese deep-water longline fishery targeting black scabbardfish in ICES Division 9.a and Subarea 10. As a response, Portugal has proposed an action plan focusing the black scabbardfish fishery and this plan is coordinated by the Portuguese General Directorate of Fisheries. Among other objectives, under this plan different management strategies were expected to be evaluated.

The council regulation (EU) 2021/91 fixing, for the years 2021 and 2022, the fishing opportunities for Union fishing vessels for certain deep-sea fish stocks, prohibits to fish for deep-sea sharks in ICES subareas 5 to 9, in Union and international waters of ICES subarea 10, in international waters of ICES subarea 12 and in Union waters of CECAF areas 34.1.1, 34.1.2 and 34.2, and to retain on board, tranship, relocate or land deep-sea sharks caught in those areas, with no exceptions.

3.3 Catch data

3.3.1 Landings

Landings of leafscale gulper shark and Portuguese dogfish have historically been included by many countries in mixed landings categories (e.g. sharks 'nei' and dogfish 'nei').

During WKSHARK2, landing data provided by country was revised in relation to data quality (including taxonomic categories). Protocols to better document the decisions to be made when estimating WG landings were also developed (ICES, 2016).

For the years before 2005, it was not possible to determine identity to species level and hence the landings presented here are of "siki" sharks. "Siki" landings are a mixed category comprising mainly *C. squamosus* and *C. coelolepis* but also including unknown quantities of other species (Table 3.1). Past efforts made by WGEF to assign mixed landings by species are described in the Stock Annex. Landings estimates from 2005 onwards were revised following WKSHARK2, and are presented by species (Tables 3.2 and 3.3).

Figure 3.1 shows the Working Group estimates of combined landings of the two species by country and Figure 3.2 shows Working Group estimates of combined landings of the two species by ICES area.

Landings have declined from around 10 000 t in 2001–2004 to one tonne in 2012. The recent decrease in landings is mostly related to the imposition of the EU TAC, which has been set at zero catch since 2010. In 2020, Portugal landed 4.3 and 8.8 tonnes of leafscale gulper shark and Portuguese dogfish, respectively.

3.3.2 Discards

Since 2010, and excluding the limited by-catch allowance for the longline fisheries (see section 3.3.5) in 2017–2020, the EU TACs for deep-water sharks have been zero, and consequently it was admitted that the discarding in deep-water fisheries had increased. However, with the several EU regulations in place, particularly the ban of gillnet, entangle and trammel net fisheries at depths >600 m and trawl deep-water fisheries at depths >800 m, the potential bycatch and subsequent discarding of Portuguese dogfish and leafscale gulper shark is now thought to be relatively low. Since 2010, that discard information is limited to some years and countries.

Portugal. The IPMA on-board sampling programme of Portuguese commercial vessels that operate deep-water longlines to target black scabbardfish (métier LLD_DWS_0_0_0), started in mid-2005. Sampling effort was fixed at three trips per quarter and sampled trips and vessels were selected in a quasi-random sampling (Fernandes *et al*., 2011 WD). However, it is considered that spatial coverage by the sampling is insufficient to allow discards to be raised to the whole fleet (Prista *et al*., 2014 WD).

To evaluate the level of shark bycatch and discards, and to increase knowledge of the fishery, a pilot study on the Portuguese trammel net fishery targeting anglerfish in Division 9.a (200–600 m deep) took place, under the PNAB/DCF from 2012–2014 (Moura *et al*., 2015 WD). Results showed that the fishery targeting anglerfish at depths of 200–600 m had a low frequency of occurrence of Portuguese dogfish. No specimens of leafscale gulper shark were ever sampled. Despite these results, higher frequencies are likely to be observed at depths >600 m.

Spain. The Spanish Discards Sampling Programme for Otter and Pair Bottom Trawl (OTB and PTB) fleets, covering ICES subareas 6–7 and divisions 8.c and 9.a started in 1988; however, it did not have annual coverage until 2003. The sampling strategy and the estimation methodology used follows the "Workshop on Discard Sampling Methodology and Raising Procedures" guidelines (ICES, 2003) and more details of this applied to this area were explained in Santos *et al*. (2010 WD).

Estimated discards of leafscale gulper shark in 2019 were 0.4 tonnes.

Discards of *Centrophorus* spp. are presented in Table 3.5. The estimates are not species-specific; it is unknown whether observers have the necessary identification skills and experience to reliably identify the various species. It should also be noted that observer coverage in this fishery is low and thus a very large raising factor was applied. The species composition of discards suggests that the fishery operates at depths shallower than the usual depth range for *Centrophorus* spp. As a consequence, it is admitted that *Centrophorus* contribute for only a small percentage of the total discards. It does not appear that the sampling has been stratified to account for this depth effect and this probably explains the high inter-annual variation. The results presented in Table 3.4 can therefore not be considered reliable estimates of the quantities discarded. They are included in this report as indicative that some discarding of this genus does occur, and this may be of relatively large magnitude.

France. Estimated discards of Portuguese dogfish and leafscale gulper shark from the trawl fleet in 2018 were 172 tonnes.

In 2012 (10 vessels), 2013 (12 vessels) and 2014 (11 vessels) landed >10 tonnes of roundnose grenadier *Coryphanoides rupestris*, black scabbardfish *Aphanopus carbo* and blue ling *Molva dypterygia*. The catch of these 10–12 vessels represented 99% of the total French landings per year of these three species. In the three years, from 2012 to 2014, observers were onboard at 7, 10 and 8 of these vessels, respectively. The fishery for these three deep-water species is carried out to the west of Scotland, Ireland and in Faroese waters. The majority of the landings are from divisions 6.a, 5.b and 7.c, with an additional 2–3% coming from 7.j. In 2014, all on-board observations came from divisions 6.a and 7.b-c.

Other deep-water species landings made from French vessels are mostly bycatch in demersal fisheries.

The depth distribution of French on-board observation was assessed by selecting all hauls where a catch of roundnose grenadier, black scabbardfish or blue ling was recorded. Over this eleven-year period, the proportion of deep hauls sampled has reduced (Figure 3.3). In 2014, no hauls deeper than 1200 m were sampled, although the on-board observations covered more than 350 hauls. WGDEEP (ICES Working Group on the Biology and Assessment of Deep-sea Fisheries Resources) made the same observation based upon logbooks reported by deep-water fishing vessels, which cover a larger number of hauls (logbooks are not used here since they only include data on landed species and not on deep-water elasmobranchs).

French bycatch of Portuguese dogfish and leafscale gulper shark occurs mainly, if not only, in the deep-water fishery to the West of Scotland. The frequency of occurrence of the two deep-water shark species in French on-board observations does not show clear trends. Variations, including lower occurrence of Portuguese dogfish in recent years or the higher occurrence in 2009–2014 of leafscale gulper shark, may result from the shallower distribution of the fishing grounds (Table 3.6).

French discards were raised using the standard procedure developed in the COST project (Anon., 2009; Jansen *et al*., 2009). The raising of discards to the total fleet activity is problematic. In addition to difficulties identified for several species, Portuguese dogfish and leafscale gulper shark are not landed so that discards cannot be raised to the discards-to-landings ratio and raising should be done using an effort measure. Raising can be done by fishing time, number of trips, number of fishing operations and number of fishing days. Raising to those fishing effort variables returned different discard estimates, which range from 13–200 tonnes of Portuguese dogfish and from 40–700 tonnes of leafscale gulper shark.

Ireland. Discard data from Ireland is available from 2009 to 2017 for the Portuguese dogfish from the trawl fleet operating in ICES divisions 27.6.a and 27.7.bgj. Discards are considered negligible as values estimated are <1 tonne in most of the years.

3.3.3 Quality of the catch data

Historically, very few countries have provided landings data disaggregated by species. Portugal has supplied species-specific data for many years. Since 2003 onwards, other countries have increased species-specific reporting of landings but some of these data may contain misidentifications.

Furthermore, it is believed that immediately prior to the introduction of quotas for deep-water species in 2001, some vessels may have reported deep-water sharks as other species (and vice versa) in an effort to build up track record for other deep-water species (or deep-water sharks). It was also likely that, before the introduction of quotas for deep-water sharks, some gillnetters may have reported monkfish as sharks.

Misreporting is likely to have increased as a reaction to the EU restrictive measures adopted for deep-water sharks. As an example, the data from the DCF landing sampling programme at Sesimbra landing port in 2009 and 2010 revealed the existence of misidentification problems (Lagarto *et al*., 2012 WD). In 2014, sampling data derived from 13 trips on deep-water longliners (a small proportion of the total number of trips) indicate that nearly 50% of the sampled specimens landed as *Galeorhinus galeus* corresponded to leafscale gulper shark and Portuguese dogfish. Misidentification issues persisted until 2016.

IUU fishing is thought to occur, especially in international waters.

3.3.4 Discard survival

No information is available for commercial fishing operations. Scientific studies have recently tagged leafscale gulper sharks caught by longline at depths of 900–1100 m, indicating that they are capable of surviving after capture and release (Rodríguez-Cabello and Sánchez, 2014; Rodríguez-Cabello and Sánchez, 2017). In this studies, at-vessel mortality (for *C. squamosus* and *C. coelolepis* (proportion of fish that are dead when the fish are brought on board) was low: 1.2%, and 4.5%, respectively. However, if including also specimens scored in poor condition, at vessel mortality increased to 18.9% and 38.6%, respectively.

It is important to remark that in these studies, the soaking times were restricted to 2–3 hours and the fishing gear was hauled in at a much slower speed (0.4–0.5 m s^{-1}) than under normal fishing practices.

3.4 Commercial catch composition

3.4.1 Species composition

No new information.

Between 2006 and 2011, WGEF, using catch ratios from various historical sources, made a number of attempts to split mixed landings data by species. The benchmarked procedure agreed by

WKDEEP 2010 is described in the Stock Annex. This methodology was further explored by a dedicated workshop on splitting of deep-water shark historical catch data in 2011 (ICES, 2011). Results from this meeting indicated that the ratio between leafscale gulper shark and Portuguese dogfish varied considerably both temporally and spatially data from 2005 onwards was revised in WKSHARK2.

3.4.2 Length composition

No new information is available.

3.4.3 Quality of catch and biological data

Despite past efforts to improve the quality of data, particularly on species composition, considerable uncertainties persist on historical data (ICES, 2011; ICES, 2016).

Since the reduction of EU TACs to zero, significant quantities of the two deep-water shark species under consideration are likely to be discarded by deep-water fisheries. Despite some sampling effort on discards has been undertaken, the sampling effort is clearly insufficient to estimate the quantities caught.

3.5 Commercial catch-effort data

No new data.

3.6 Fishery-independent surveys

Since 1996, Marine Scotland Science has been conducting a monitoring deep-water survey in Subarea 6 at depths ranging from 300–2040 m. This survey can be considered to be standardised in terms of depth coverage since 1998. More information on this survey is presented below.

In September, from 2006 to 2008, and in December 2009, Ireland carried out annual deep-water surveys in subareas 6 and 7. Fishing hauls were performed off north-western Ireland and west of Scotland, and the Porcupine Bank area to the west of Ireland at depth strata: 500 m, 1000 m, 1500 m and 1800 m. No further surveys have since taken place. The Irish deep-water survey and other surveys were part of a planned coordinated survey in the ICES area, through the Planning Group on Northeast Atlantic Continental Slope Surveys (WGNEACS).

A new Irish trawl survey (IAMS) began trawling deep-water stations in 2018, but data have not yet been analysed.

The WGNEACS 2012 was dedicated mainly to the design of a longline survey in Bay of Biscay and Iberian waters. One of its main objectives would be to clarify the distribution of all the deep-water sharks and to provide data to monitor their stock status, in the absence of commercial fisheries data.

From 2015 to 2020, AZTI conducted a deep-water longline survey (PALPROF) along the Basque Coast, Bay of Biscay (ICES Division 8.c), onboard a commercial longliner. More information on this survey is presented below.

3.7 Life-history information

No new information.

3.8 Exploratory assessments

3.8.1 Analyses of Scottish deep-water survey data

Survey indicators from the Scottish deep-water survey have been investigated since 2012 (Figures 3.4 and 3.5. There was no new work on this data in 2021, see reports from previous years for a full account.

3.8.2 Analyses of AZTI survey

New information from the PALPROF survey in the Bay of Biscay, updating the data presented previously (WD01 - Diez *et al.*, 2021). The PALPROF survey was conducted annually from 2015 to 2020 with the main objective of estimating and assessing the inter-annual variation of the abundance and biomass indices of the deep-water sharks and other ichthyofauna. The surveyed area is located in an area 10.5 km North of the Cape Matxitxako (ICES 27.8.c east) close to a narrow canyon of about 28 km length, where the bottom depth progressively increases from 500 to 2500 m. Based on canyon valley depth profile and for a depth range from 650 m to 2400 m, 400 m depth interval strata were considered. In each survey six fishing hauls were performed. To get homogeneous and comparable data series the six hauls were repeated every year in the same position and at the same time of the year.

To minimize the mortality of deep-water sharks, the number of hooks of a former commercial deep-water-sharks longline was reduced to 300. Five small sensors DST CTD and DST centi (www.star-oddi.com) were used to continuously monitor depth, temperature and salinity (every 30 s). The sensors were able to withstand 2400–3000 m in depth, respectively, and were placed on the main line of fishing gear (Figure 3.6).

Data on status of the hook were recorded during the hauling and the recovering of the long line. The categories considered were: i) **E** - Hook with bait; ii) **C** - Hook with bait partially eaten; iii) **R** - Broken-Tangled hook; iv) **V** - Empty hook (no catch, no bait); v) **P** - Hook with catch and vi) **N.O.** - Hook status not Observed/recorded during recovering of the line.

On board, all fish specimens caught were sorted and species identified to the lowest taxonomic level possible. Also, each specimen was measured (cm), sexed and the condition (dead or alive) recorded. Individual body weight was estimated based on species length/weight relationships. The effective fishing effort performed in each stratum (EFFORTst) corresponded to the number of hooks able to fish during the haul, i.e. P + E + C divided by the total of hooks and multiplied by the soaking time (minutes):

EFFORTst: ((P + E + C) / total hooks) x soak time (minutes)

For each *stratum* the CPUE of species **i** was calculated as the ratio of catch of i^{th} species (kg) and EFFORTst.

During the six years of the survey, 13 different species of sharks and 2 chimaeras were caught. Sharks and chimaeras were less frequently caught in the floating sections of the fishing gear than at the bottom sections (Figure 3.7). The highest CPUE values were recorded for *C. coelolepis*, especially in 2016, 2019 and 2020. The CPUE values for *C. squamosus* were variable, but close to 25 kg $hook^{-1}$ min^{-1} in 2018, decreasing since then (Figure 3.13). Abundance of *C. coelolepis* was highest in the 1451–1850 strata whereas *C. squamosus* presented similar percentage of abundance in the 1051–1450 m and in the 1451–1850 strata.

3.8.3 Analyses of on-board Portuguese data

IPMA analysed the onboard data collected under Data Collection Framework (PNAB/DCF) for the deep-water sharks *Centroscymnus coelolepis*, *Centrophorus squamosus* and *Deania calceus* (Figueiredo and Moura, 2019WD). The analysis covered a period from 2009 to 2018 during which data on deep-water sharks was collected by onboard observers of the deep-water longline fishery targeting the black scabbardfish (LLD-DWS *métier*) in Division 9.a.

The sampling effort assigned to LLD-DWS *métier* was settled following the Neyman criterion. According to this, the optimum number of trips to be performed per vessel at Sesimbra landing port was estimated as 3 trips per month (margin of error of 1 with 95% probability). Several factors have been constraining the reach of this target and the sampling effort obtained thought time has been much lower.

Figure 3.8 presents, for each year, the geographic locations of the sampled fishing hauls for the whole set of on-board fishing trips. Before 2014, sampled fishing hauls were mainly located northwards while after, the fishing hauls locations were more disperse, covering a more southern area. Important to note that these spatial differences do not reflect any change on fleet dynamics but are rather related to the opportunistic feature of the LLD-DWS *métier* sampling plan.

The initial objective of this analysis was to estimate the level of by-catch of the main deep-water sharks by year and by area in addition to evaluate any potential trend during this time period, to compare with catch levels prior to 2007 (when the TAC started to restrict landings). However, the sampling effort achieved is considered insufficient to provide reliable information on the abundance or biomass trend of deep-water shark species. The spatial locations of the fishing hauls are heterogeneously dispersed along time and the vessels sampled also changed. It should be noted that given the vessel site fidelity, there is a confounding effect between the fishing vessel and the fishing grounds and with the distribution patterns of each species, difficult to disentangle. The results obtained from the onboard analysis are presents below, by species.

Portuguese dogfish. The relative occurrence of *C. coelolepis* at the sampled fishing hauls, by year, varied between 33 and 100%. The number of specimens caught varied, not only among years, but also among vessels. The highest number of specimens caught by fishing haul were consistently recorded in some places (Figure 3.9). The geographic information of the catches of *C. coelolepis* supports previous studies where it was concluded that the black scabbardfish fishery operate at locations of lower abundance of *C. coelolepis* (Veiga *et al.*, 2015 WD). This species is thought to be able to complete its life cycle in the same geographical area (although sampling data on newborns is scarce) (Moura *et al.*, 2014) suggesting the existence of local populations.

Leafscale gulper shark. *Centrophorus squamosus* was quite frequently caught but its relative occurrence by fishing haul and by year varied between 17 and 100%. Also, the number of specimens caught per fishing haul varied not only among years but also among vessels. The data available were considered insufficient to estimate the level of by-catch and did not put in evidence any temporal trend. This fact might be associated with the spatial changes of the sampled fishing hauls along time (Figure 3.10).

3.9 Stock assessment

No new assessments were undertaken in 2021.

3.10 Quality of the assessments

The knowledge of deep-water shark species distribution and stock structure in the northeast Atlantic are highly deficient. Available abundance and biomass indices are restricted to a few areas and estimates are highly variable and uncertain. Furthermore, the data derived from discards sampling is not adequate to estimate the quantities caught or needs further investigation. Therefore, a major scientific investment is required to gain a full understanding of the spatial and temporal population dynamics of deep-water sharks to enable estimates of sustainable exploitation levels. Several strategies to be adopted to monitor species abundance and evaluate fishing impact on their populations by the different deep-water fisheries have been discussed in previous meetings and included the: i) increase of close monitoring of deep water shark populations; ii) development of specific studies to assess the distribution patterns of species and estimate the spatial overlap with fisheries; iii) evaluation of the effect on the by catch of deep water sharks of modifications in deep water fishing operations (Figueiredo and Moura, 2016 WD)

In the absence of fishery-dependent data, the status of these species can only be ascertained from fishery-independent data. Abundance indices used in previous assessments were exclusively derived from the Scottish deep-water survey. However, there are concerns of applying this survey to infer stock status as the Scottish survey takes place in a small proportion of the management area. Furthermore, these data are only available for the period after the development of the fishery. There are no fishery-independent data for areas further south, which prevents understanding of trends in abundance in these areas.

Many countries formerly reported landings of Portuguese dogfish and leafscale gulper shark combined with other deep-water sharks in categories such as “siki sharks”. Unless suitable data can be found to enable splitting of the catch data, historical catch levels by species will remain uncertain.

3.10.1 Historical assessments

The application of the benchmarked model requires historical data discriminated by species from the different areas within the stock NE Atlantic. Such data is unavailable, as historical data is not split by species. Efforts so far, e.g. WKSHARK (ICES, 2011) were not able to split the historical data. Current discard estimates are not standardized yet so it cannot be used for further catch estimates.

3.11 Reference points

There are not reference points for these stocks.

3.12 Conservation considerations

The Red List of European marine fish considered both leafscale gulper shark and Portuguese dogfish to be Endangered (Nieto *et al*., 2015).

Recent IUCN assessments for a group of deep-water sharks classified the Portuguese dogfish as globally Near Threatened with signs of increase in the population inhabiting the NE Atlantic (Finucci *et al.*, 2020a). The Leafscale gulper shark was classified as globally Endangered, with signs of reduction of the population in the NE Atlantic (Finucci *et al*. 2020b).

3.13 Management considerations

Some species of deep-water shark are considered to have very low population productivity.

Based on the precautionary approach, ICES has routinely advised against targeted fisheries on leafscale gulper shark and Portuguese dogfish.

Whilst the zero TAC for deep-water sharks has prevented targeted fisheries for deep-water sharks, these species can still be a bycatch in some deep-water fisheries. The level of bycatch in these fisheries is uncertain but is now assumed to be relatively low given the EU regulations adopted for deep-water fisheries (see Section 3.3.5).

There are limited data to evaluate the stocks of these species. The Scottish deep-water survey provides a meaningful time-series of species-specific data, but this started after the fishery being established, and only covers part of the stock range for both the leafscale gulper shark and the Portuguese dogfish. The PALPROF survey in the Bay of Biscay provides new fishery-independent data since 2015, but also covers a small area. Fishery-independent data from other areas of the stock range are limited or lacking.

3.14 References

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Table 3.1. Deep-water sharks - Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (subareas 4–14). Working Group estimate of combined landings of Portuguese dogfish and leafscale gulper shark (t) by ICES area from 1998 to 2004. Landings by species not available in these years, UA, unknown area.

	4.a	5.a	5.b	6	7	8	9	10	12	14	UA	Total
1988	0	0	0	0	0	0	560	0	0	0		560
1989	12	0	0	8	0	0	507	0	0	0		527
1990	8	0	140	6	0	6	475	0	0	0		635
1991	10	0	75	1013	265	70	1075	0	1	0		2509
1992	140	1	123	2013	1171	62	1114	0	2	0		4626
1993	63	1	97	2781	1232	25	946	0	7	0		5152
1994	98	0	198	2872	2087	36	1155	0	9	0		6455
1995	78	0	272	2824	1800	45	1354	0	139	0		6512
1996	298	0	391	3639	1168	336	1189	0	147	0		7168
1997	227	0	328	4135	1637	503	1311	0	32	9		8182
1998	81	5	552	4133	1038	605	1220	0	56	15		7705
1999	55	0	469	3471	895	531	972	0	91	0		6484
2000	1	1	410	3455	892	361	1049	0	890	0		7059
2001	3	0	475	4459	2685	634	1130	0	719	0		10105
2002	10	0	215	3086	1487	669	1198	0	1416	12		8093
2003	16	0	300	3855	3926	746	1180	0	849	4		10876
2004	5	0	229	2754	3477	674	1125	0	767	0		9031

Table 3.2. Deep-water sharks - Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (subareas 4–14). Working Group estimate of landings of Portuguese dogfish (t) by ICES area. FAO34, FAO area 34, UA, unknown area. 0 = landings <0.5 t.

	27.2	27.4	27.5	27.6	27.7	27.8	27.9	27.10	27.12	27-UA	FAO34	TOTAL
2005	0	2	149	414	392	92	541	0	8	60	256	1913
2006	0	1	138	244	214	106	537		0		25	1265
2007	0	2	133	186	14	29	143				0	507
2008		0	121	145	7	361	86				0	394
2009		0	27	47	3	4	33					114
2010		0	31	24	2	0	1				0	59
2011			1		1		1					2
2012			4				0					4
2013			2				0				0	3
2014			5								0	6
2015		0				0	0					1
2016					0	0						0
2017							3*					3
2018						0	2*					2
2019							11*					11
2020						0	9*					9

*** Landings from the deep-sea longline fisheries for black scabbardfish (Council regulation (EU) 2016/2285; Council regulation (EU) 2018/2025).**

Table 3.3. Deep-water sharks - Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (subareas 4–14). Working Group estimate of landings of leafscale gulper shark (t) by ICES area. FAO34, FAO area 34; UA, unknown area. 0 = landings <0.5 t.

	27.2	27.4	27.5	27.6	27.7	27.8	27.9	27.10	27.12	27-UA	FAO34	TOTAL
2005	0	0	32	189	249	154	457	0	1	64	565	1712
2006		0	47	158	95	50	508		0		50	908
2007	0	0	44	28	26	2	231				0	331
2008		0	41	43	15	3	87				7	197
2009		0	50	83	4	1	26				13	177
2010		0	58	59	12	0	4				5	139
2011					3		1				3	6
2012					1		1				5	8
2013							0				4	4
2014			32		0		0				3	35
2015		1	9			0	0					10
2016							0					0
2017							7*				9*	16
2018							2*				9*	11
2019							17*				11*	28
2020		0					4*				8*	13

*** Landings from the deep-sea longline fisheries for black scabbardfish (Council regulation (EU) 2016/2285; Council regulation (EU) 2018/2025).**

Table 3.4. Deep-water sharks - Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (subareas 4–14). Fishing hauls depth and proportion values of both species from the pilot study conducted onboard of commercial fishing vessels from the Portuguese mainland black scabbard fishery. PCYO, proportion of Portuguese dogfish; PGUQ proportion of leafscale gulper shark.

	BSF fishing grounds (depth, m)	Deeper fishing grounds (depth, m)	BSF fishing ground		Deeper fishing ground	
			P_{CYO}	P_{GUQ}	P_{CYO}	P_{GUQ}
Vessel 1	1170	1463	---	0.026	0.884	0.881
Vessel 2	1357	1461	---	0.148	0.893	0.334
Vessel 3	1180	1376	0.224	0.074	0.720	0.267
Vessel 4	1198	1382	0.122	0.112	0.820	0.734
Vessel 5	1189	1445	0.058	0.110	0.279	0.044

Table 3.5. Deep-water sharks - Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (subareas 4–14). Spanish discard data for *Centrophorus* spp. Numbers of sampled trips and total trips are not yet available for the years 2010 onward.

Year	Celtic Sea (subareas 6–7)			Iberian Waters (divisions 8.c–9.a))		
	Sampled trips	Total trips	Raised discards (t)	Sampled trips	Total trips	Raised discards (t)
2003	9	1172	0	51	18 036	0
2004	11	1222	0	53	20 819	0
2005	10	1194	0	97	11 693	4.5
2006	13	1152	3.2	75	18 352	4.1
2007	12	1233	0	95	17 750	0
2008	11	1206	67.3	103	15 114	0
2009	15	1304	61.1	116	14 486	85.9
2010			0			29.2
2011			0			0.9
2012			173.4			0.7
2013			0			0

Table 3.6. Deep-water sharks - Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (subareas 4–14). Total number of fishing trips, number of hauls and number of hauls with catch of Portuguese dogfish and leafscale gulper shark in French on-board observations (2005–2014).

Year	Country	Total number of:		Portuguese dogfish (positive hauls)		Leafscale gulper shark (positive hauls)	
		Trips	Hauls	Number	Proportion	Number	Proportion
2005	France	18	212	26	0.12	9	0.04
2006	France	9	106	18	0.17	1	0.01
2007	France	6	15	1	0.07	35	0.14
2008	France	18	245	12	0.05	143	0.24
2009	France	42	605	89	0.15	120	0.24
2010	France	48	504	93	0.18	71	0.16
2011	France	29	443	67	0.15	93	0.21
2012	France	32	449	35	0.08	79	0.18
2013	France	36	447	27	0.06	72	0.20
2014	France	31	365	34	0.09	9	0.04

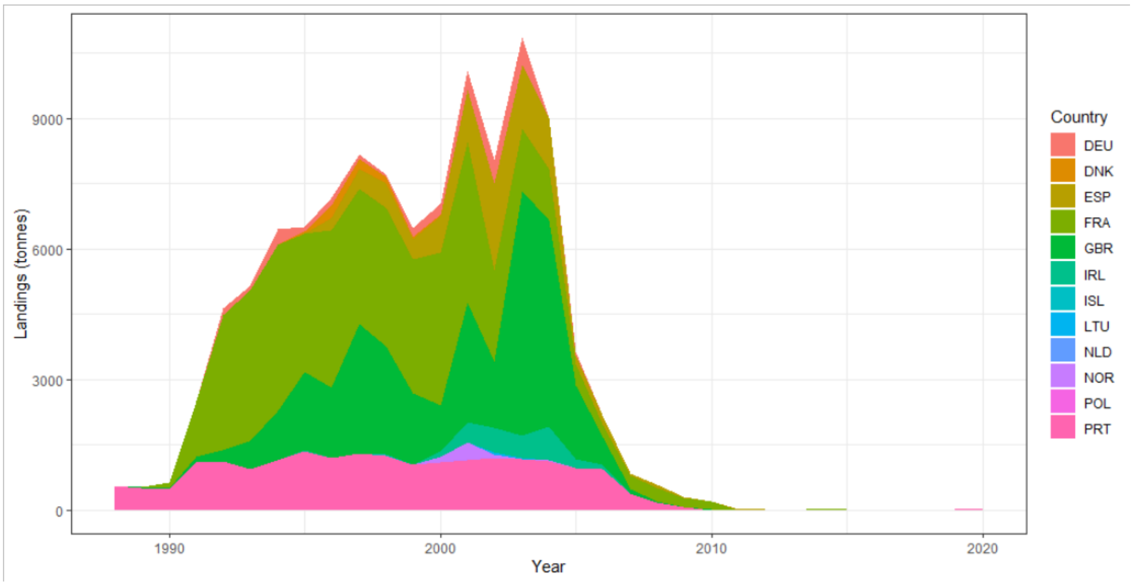

Figure 3.1. Deep-water sharks - Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (subareas 4–14). Working Group estimates of combined landings of the two species, by country.

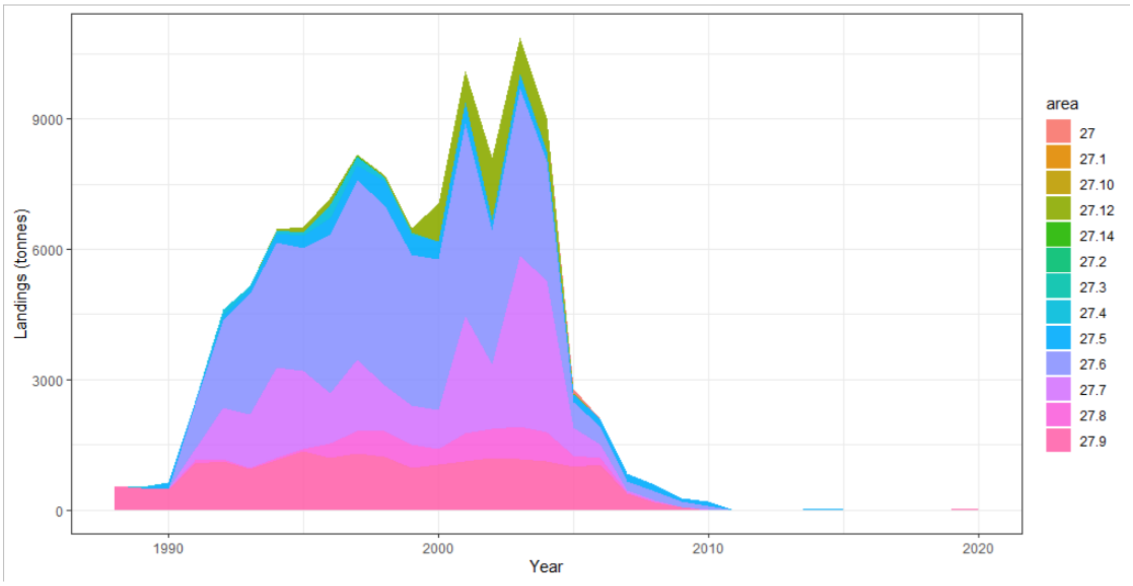

Figure 3.2. Deep-water sharks - Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (subareas 4–14). Working Group estimates of combined landings of the two species, by ICES Subarea.

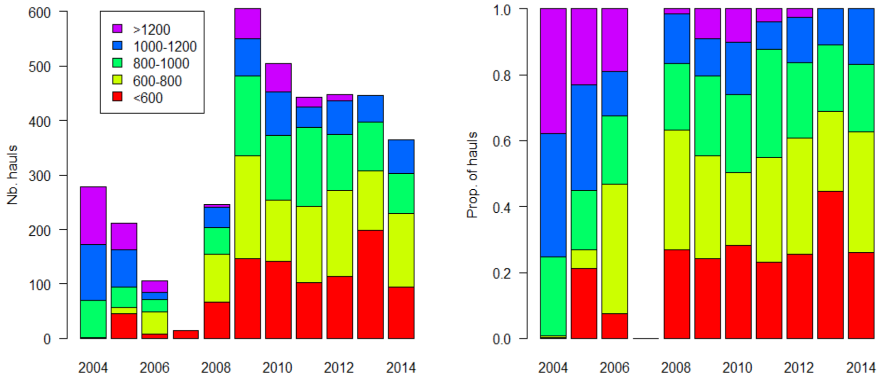

Figure 3.3. Deep-water sharks - Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (subareas 4–14). Depth distribution of on-board observation of French deep-water fisheries 2004–2014, number of hauls per 200 m depth range (left) and proportions (right), proportions in 2007 where there was no sampling dedicated to deep-water fisheries are not given.

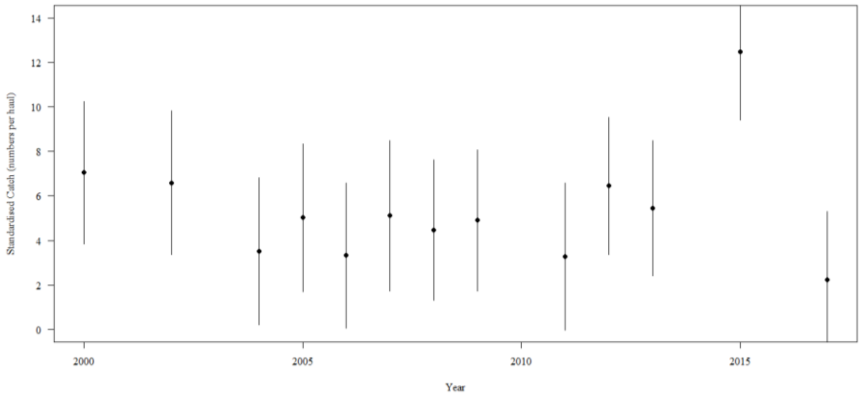

Figure 3.4. Deep-water sharks - Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (subareas 4–14). Standardized abundance index for Portuguese dogfish in Scottish deep-water surveys 2000 to 2017.

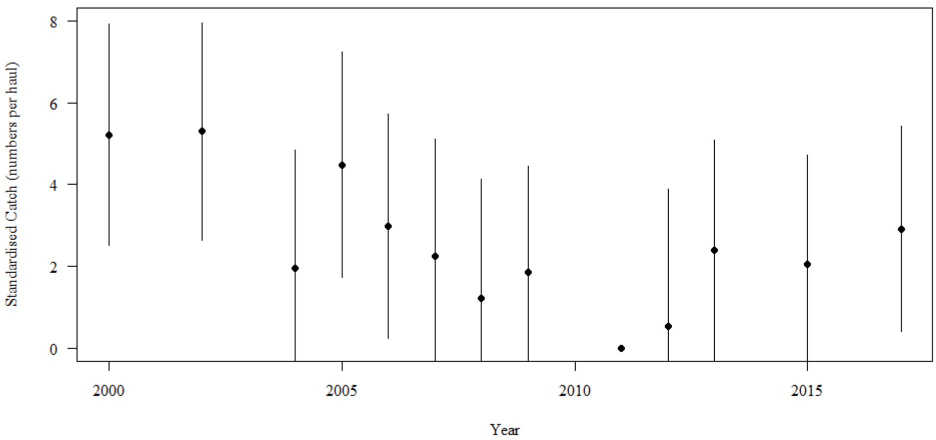

Figure 3.5. Deep-water sharks - Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (subareas 4–14). Standardized abundance index for leafscale gulper shark in Scottish deep-water surveys 2000 to 2017.

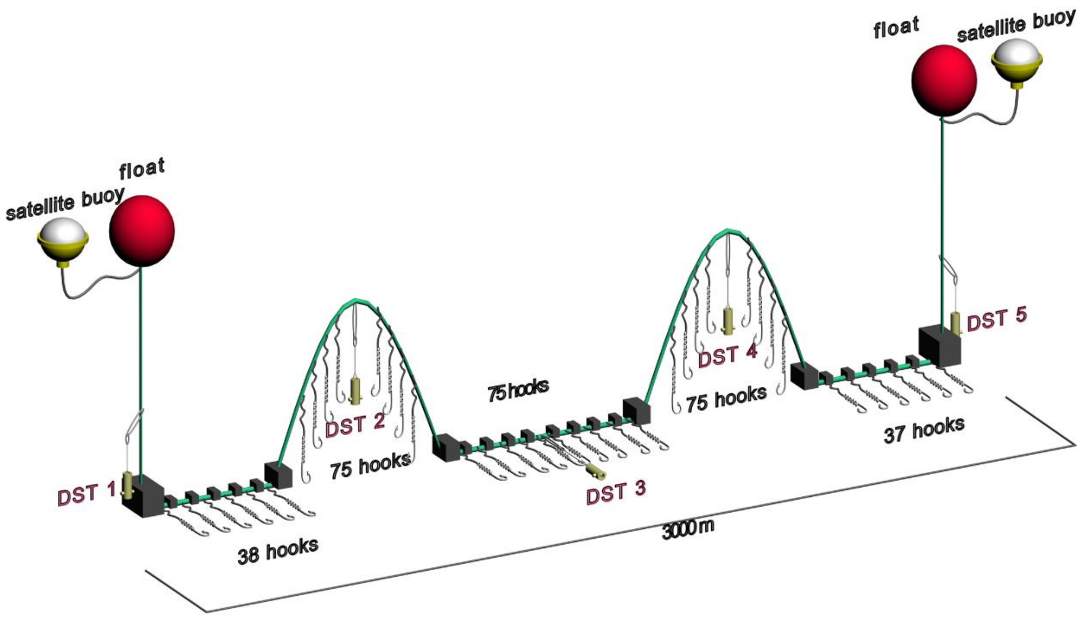

Figure 3.6. Deep-water sharks - Scheme of the final design of long-line fishing gear used in the PALPROF survey (from WD01 - Diez *et al.*, 2020).

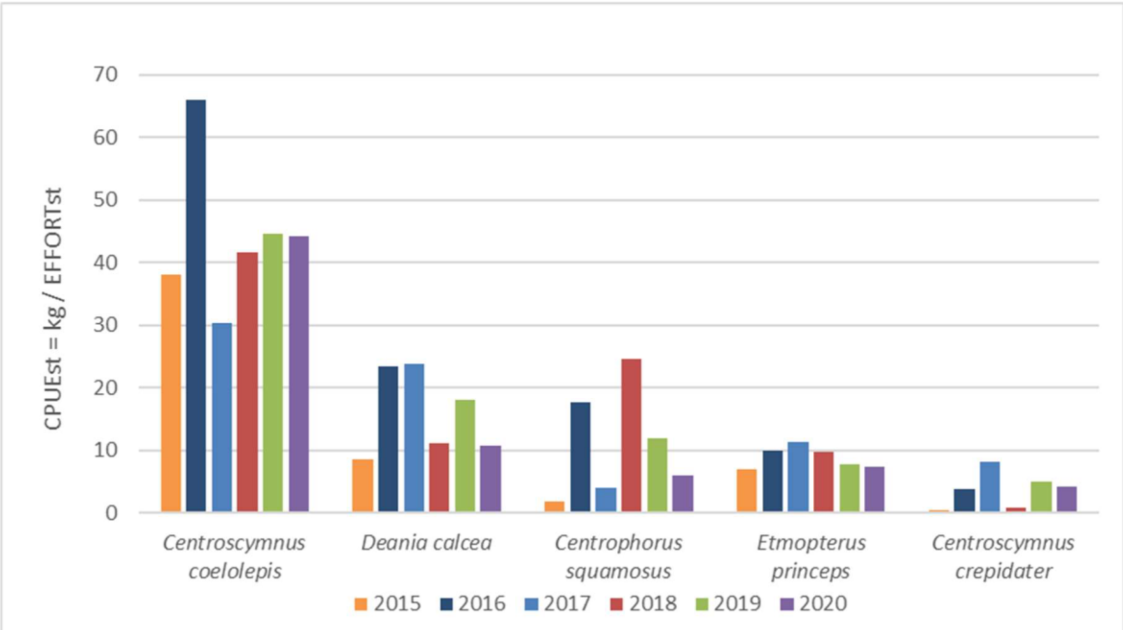

Figure 3.7 Deep-water sharks – CPUE (kg hook^{-1} min^{-1}) estimates of each of the main deep-water shark species caught by year on PALPROF survey (2015–2020; from Diez *et al.*, 2021).

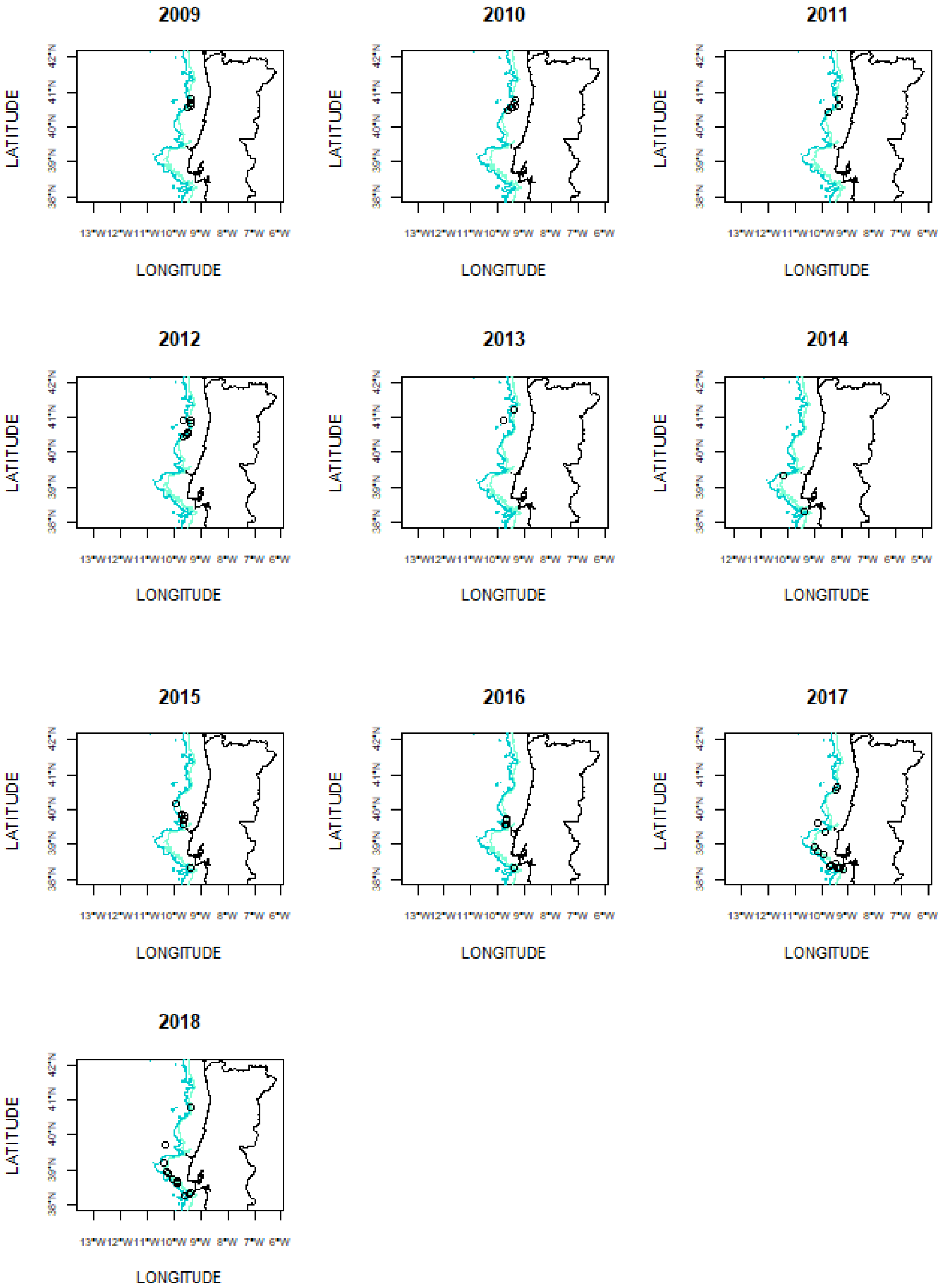

Figure 3.8. Deep-water sharks – Geographic locations of the LLS-DWS métier fishing hauls annually sampled by IPMA from 2009 to 2018.

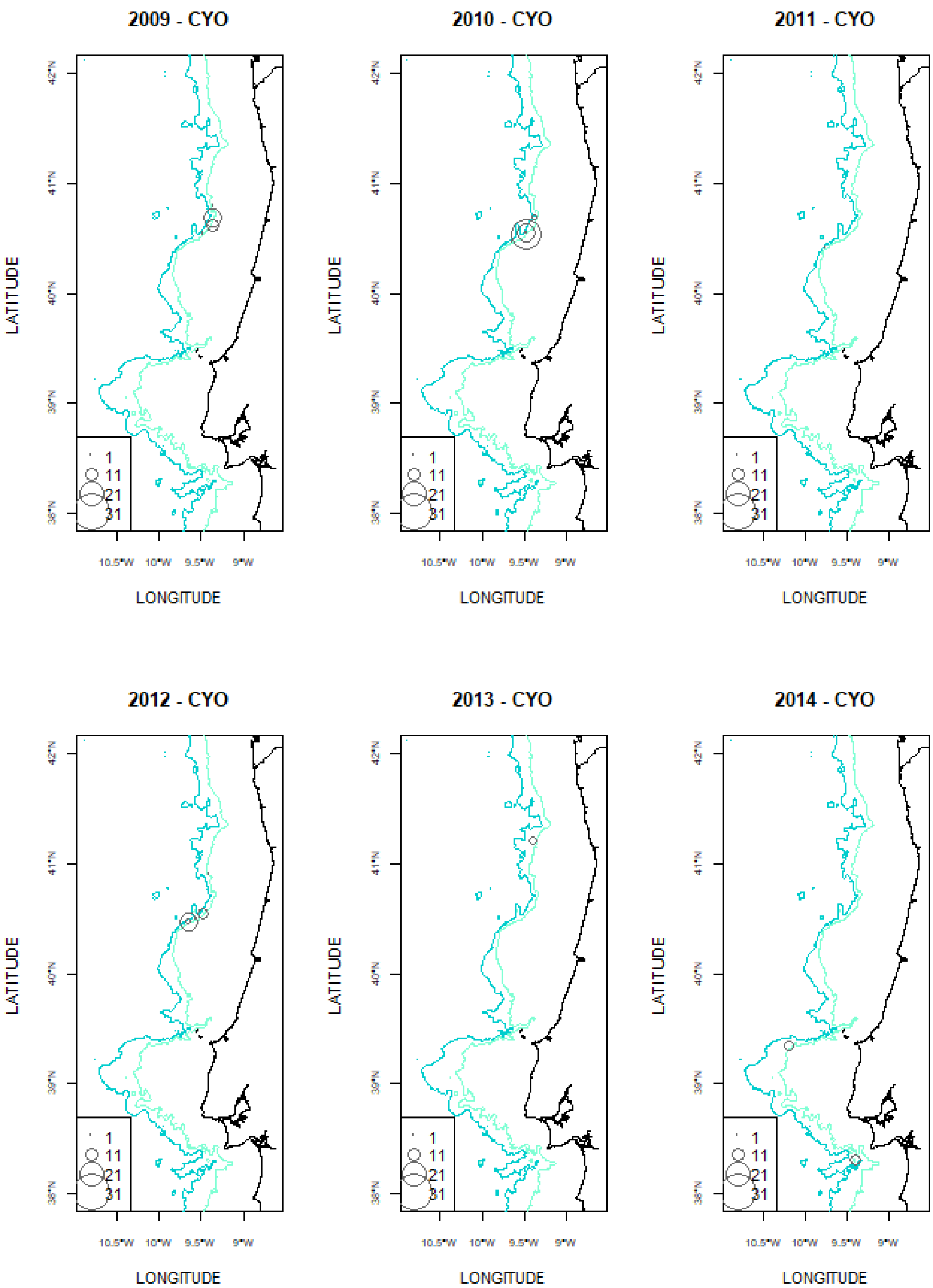

Figure 3.9. Deep-water sharks – Geographic location and number of specimens of *C. coelolepis* caught per fishing haul for the period 2009 to 2018.

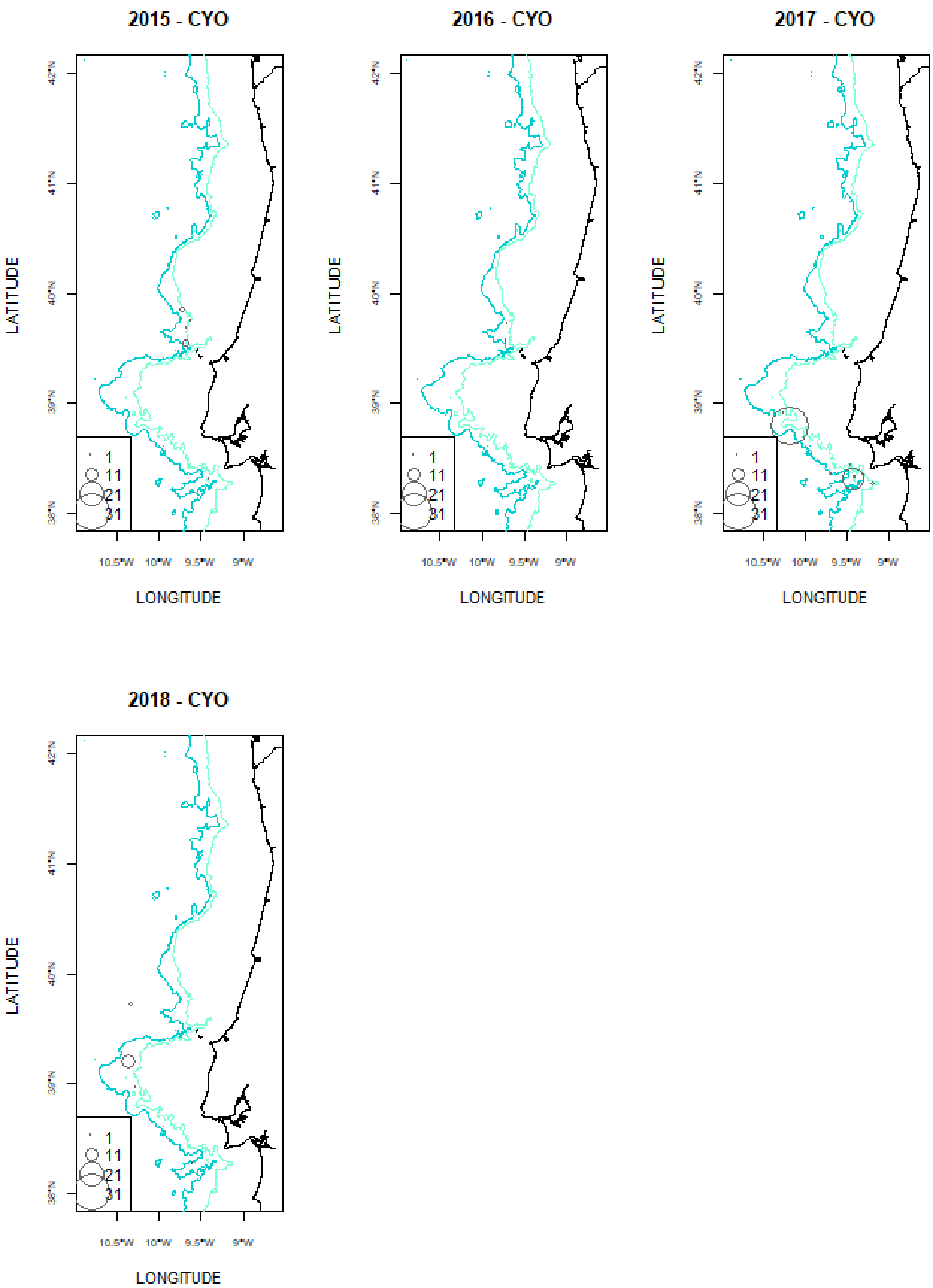

Figure 3.9 *continued* Deep-water sharks – Geographic location and number of specimens of *C. coelolepis* caught per fishing haul for the period 2009 to 2018.

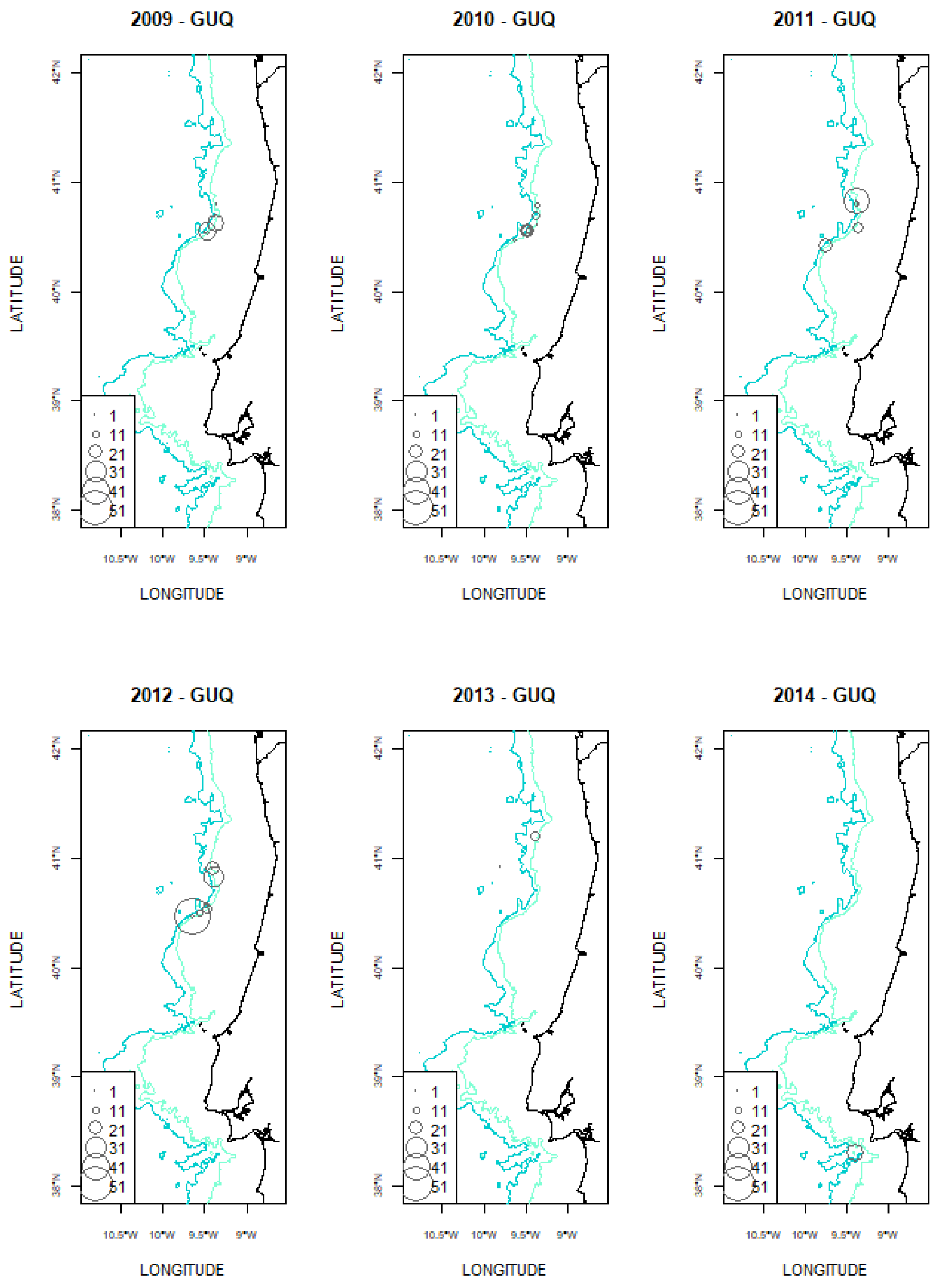

Figure 3.10. Deep-water sharks – Geographic location and number of specimens of *C. squamosus* caught per fishing haul for the period 2009 to 2018.

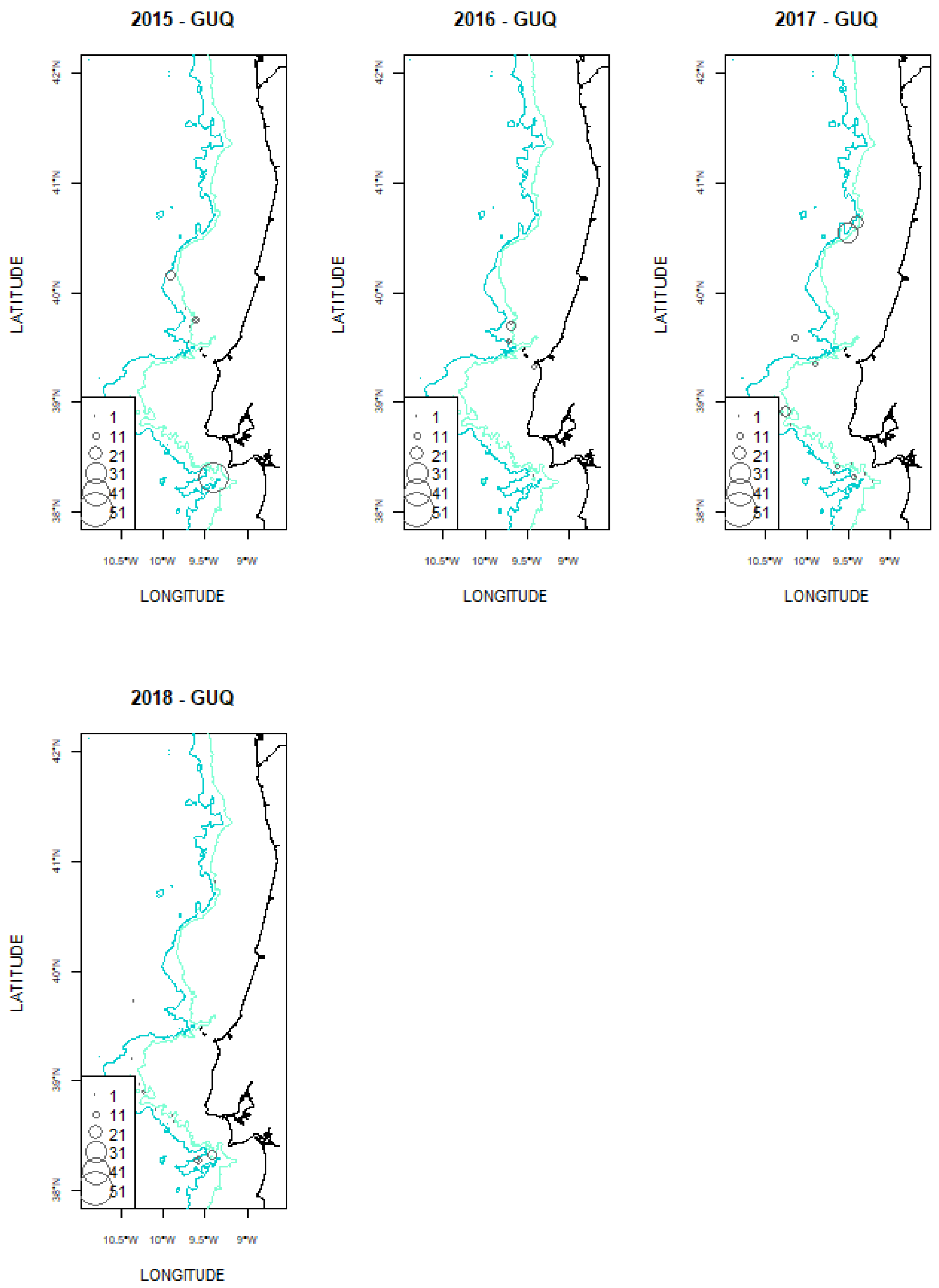

Figure 3.10. ***continued*** **Deep-water sharks – Geographic location and number of specimens of *C. squamosus* caught per fishing haul for the period 2009 to 2018.**

4 Kitefin shark in the Northeast Atlantic (entire ICES Area)

4.1 Stock distribution

Kitefin shark *Dalatias licha* is distributed widely in the deeper waters of the northeast Atlantic, from Norway to northwest Africa and the Gulf of Guinea, including the Mediterranean Sea and NW Atlantic.

The stock identity of kitefin shark in the NE Atlantic is unknown. However, the species seems to be more abundant in the southern area of the Mid-Atlantic Ridge (Subarea 10). Elsewhere in the NE Atlantic, kitefin shark is recorded infrequently. The species is caught as bycatch in mixed deep-water fisheries in subareas 5–7, although at much lesser abundance than the main deep-water sharks (see Section 3), and the species composition of the landings is not accurately known.

For assessment purposes, the Azorean stock (Subarea 10) is considered as a management unit.

4.2 The fishery

4.2.1 History of the fishery

A detailed description of historical fisheries can be found in Heessen (2003) and ICES (2003). The Azorean target fishery stopped at the end of the 1990s. Elsewhere in the North Atlantic, it is a frequent bycatch in various deep-water fisheries.

Historically, Azorean landings of kitefin shark began in the early 1970s and increased rapidly to over 947 tonnes in 1981, fluctuating considerably thereafter, at least in part due to market fluctuations. Landings peaked at 937 tonnes in 1984 and 896 tonnes in 1991. In the 1990s, these landings have declined, possibly as a result of economic problems related to markets. From the early 1990s there has been some landings from other areas, which have declined from 2005 following the implementation and reduction over time of the TAC for deepsea sharks.

4.2.2 The fishery in 2020

Currently there are no target fisheries for kitefin shark. Landings in the northeast Atlantic have been at low levels since 2005, with most of the catches reported from subareas 7, 8 and 10 (Table 4.1 and Figure 4.1). Small reported landings may correspond to coding errors.

4.2.3 ICES advice applicable

ICES advised in 2019 that "*when the precautionary approach is applied, there should be zero catches in each of the years 2020–2023*".

This is similar to the 2006 advice where ICES advised: "*This stock is managed as part of the deep-sea shark fisheries. No targeted fisheries should be permitted unless there are reliable estimates of current exploitation rates and sufficient data to assess productivity. It is recommended that exploitation of this species should only be allowed when indicators and reference points for future harvest have been identified and a management strategy, including appropriate monitoring requirements has been decided upon and is implemented*".

4.2.4 Management applicable

The EU TACs that have been adopted for deep-sea sharks in European Community waters and international waters in different ICES subareas are summarized in the table below. The deep-sea shark category includes the kitefin shark *Dalatias licha* (Council regulation (EC) No 2285/2016).

Year	Subareas 5–9	Subarea 10	Subarea 12 (includes also *Deania histricosa* and *Deania profondorum*
2005 and 2006	6763	14	243
2007	2472(1)	20	99
2008	1646(1)	20	49
2009	824(1)	10(1)	25(1)
2010	0(2)	0(2)	0(2)
2011	0(3)	0(3)	0(3)
2012	0	0	0
2013	0	0	0
2014	0	0	0
2015	0	0	0
2016	0	0	0
2017	10(4)	10(4)	0
2018	10(4)	10(4)	0
2019	7(4)	7(4)	0
2020	7(4)	7(4)	0

(1) Bycatches only. No directed fisheries for deep-sea sharks are permitted.

(2) Bycatches of up to 10% of 2009 quotas are permitted.

(3) Bycatches of up to 3% of 2009 quotas are permitted.

(4) Bycatch only for bottom longline fisheries targeting black scabbardfish

Council Regulation (EC) No 1568/2005 banned the use of trawls and gillnets in waters deeper than 200 m in the Azores, Madeira and Canary Island areas.

Council Regulation (EC) No 41/2007 banned the use of gillnets by Community vessels at depths greater than 600 m in divisions 6.a-b, 7.b-c, 7.j-k and Subarea 12. A maximum bycatch of deep-water shark of 5% is allowed in hake and monkfish gillnet catches and 10% on the bottom long-line fisheries targeting black scabbardfish.

A gillnet ban in waters deeper than 200 m is also in operation in the NEAFC regulatory Area (all international waters of the ICES Area). NEAFC also ordered the removal of all such nets from these waters by 1 February 2006.

In 2009, the Azorean Regional Government introduced new technical measures for the demersal/deep-water fisheries (Portaria n.º 43/2009 de 27 de Maio de 2009) including area restrictions by vessel size and gear, and gear restrictions (hook size and maximum number of hooks on the longline gear). These measures have been adapted thereafter. In Azorean waters, there is a network of closed areas (summarized in Section 20). The Condor seamount has been closed to demersal/deep-water fisheries since 2010.

Since 2016, and in order to mitigate the potential damaging impacts of bottom trawling, fishing with bottom trawls was permitted only at, or above, a depth of 800 metres (EU Regulation 2016/2336).

A by-catch TAC for deep-water sharks was allowed for each of the years from 2017 to 2020, on a trial basis, in the directed artisanal deep-sea longline fisheries for black scabbardfish (Council regulation (EU) 2016/2285; Council regulation (EU) 2018/2025). According to this limited landing of unavoidable by-catches of deep-sea sharks were allowed and Member States should develop regional management measures for the black scabbardfish fishery and establish specific data-collection measures for deep-sea sharks to ensure their close monitoring. Specifically, 10 tonnes were allowed for deep-sea sharks in Union and international waters of ICES subareas 5, 6, 7, 8 and 9, in Union and international waters of ICES Subarea 10 and in Union waters of CECAF 34.1.1, 34.1.2 and 34.2. This allowance was in accordance with ICES indications according to which in the artisanal deep-sea longline fisheries for black scabbardfish, the restrictive catch limits lead to misreporting of unavoidable by-catches of deep-sea sharks, which are currently discarded dead.

The Council regulation (EU) 2016/2285 affects specifically the Portuguese deep-water longline fishery targeting black scabbardfish in ICES Division 9.a and Subarea 10. As a response, Portugal has proposed an action plan focusing the black scabbardfish fishery and this plan is coordinated by the Portuguese General Directorate of Fisheries. Among other objectives, under this plan different management strategies were expected to be evaluated.

The council regulation (EU) 2021/91 fixing, for the years 2021 and 2022, the fishing opportunities for Union fishing vessels for certain deep-sea fish stocks, prohibits to fish for deep-sea sharks in ICES subareas 5 to 9, in Union and international waters of ICES subarea 10, in international waters of ICES subarea 12 and in Union waters of CECAF areas 34.1.1, 34.1.2 and 34.2, and to retain on board, tranship, relocate or land deep-sea sharks caught in those areas, with no exceptions.

4.3 Catch data

4.3.1 Landings

The annual landings reported from each country are given in Table 4.1 and in Figure 4.1.

4.3.2 Discards

No new data were presented this year.

Discard rates of 15–85% of the kitefin shark caught per set were reported from the sampled Azorean longliners during 2004–2010 (ICES, 2012). Since 2011, discards may have increased due to management restrictions, or been landed as unspecified elasmobranchs.

Sporadic and low levels of kitefin shark discards were reported from the Spanish trawl fleets operating in divisions 8.c and 9.a in 2010–2012.

4.3.3 Quality of catch data

Historic landings of deep-water sharks taken in the Azores were commonly gutted, finned, beheaded and also skinned. Only the trunks and, in some cases, the livers were landed. Misidentification problems were likely to occur with other deep-water shark species in ICES Division 10.a.

The reported Azorean landings data come exclusively from the commercial first sale of fresh fish at auctions and so landings data (Table 4.1) may be underestimated.

4.4 Commercial catch composition

No new information.

4.5 Commercial catch–effort data

No new information.

4.6 Fishery-independent surveys

Existing research surveys rarely catch kitefin shark, as the surveys are not designed for the species, and thus will not provide relevant information for the assessment.

Relative abundances of kitefin shark (ind. h^{-1}) from the Scottish deep-water trawl survey (depth range 500–1000 m) were submitted in 2016 to the group (Table 4.2). These data confirm that only low numbers are caught (<10 specimens are caught each survey). For the entire survey period, a total of 34 specimens (8 males of 60–110 cm, and 26 females of 40–140 cm) have been caught.

Relative biomass estimates of kitefin shark (kg $haul^{-1}$) from the Spanish trawl survey on the Porcupine Bank were provided to WGEF (WD03 Fernández-Zapico *et al*., 2021). Few individuals were caught over the 18-year survey period (177 until 2014). In 2020, the biomass index of *D. licha* increased slightly and abundance decreased, though very little (Figure 4.2). However, the mean biomass of 2019–2020 remained low compared with the 2014–2018 values due to the peak in 2014 (Figure 4.3). Most specimens caught were 34 to 108 cm TL and were caught mainly in the deepest strata in the south, west and east of the study area (Figure 4.4–4.5).

Relative biomass estimates of kitefin shark (kg $haul^{-1}$) from the bottom trawl survey on the Northern Spanish Shelf were submitted this year to the group (Figure 4.6–4.8; WD04 Fernández-Zapico *et al*., 2021). The only caught individual sized 44 cm and was found at 577 m depth in the Central Cantabrian Sea (Figure 4.7–4.8).

The Azorean longline survey (ARQDACO(P)-Q1) has on average of 495 fishing stations per survey, covering a depth range 50–1200 m. During the period 1995–2018, a total of 102 kitefin sharks were caught, averaging about five individuals per year (Santos *et al*., 2020). Over the entire time period, specimens were caught at depths of 150–850 m and their total length ranged from 43–150 cm (Santos *et al*., 2020).

4.7 Life-history information

There is no new information available.

4.8 Exploratory assessment models

Exploratory kitefin shark stock assessments were conducted during the 1980s, using an equilibrium Fox production model (Silva, 1987). The stock was considered intensively exploited with the average observed total catches (809 t) near the estimated maximum sustainable yield (MSY = 933 t). An optimum fishing effort of 281 days fishing bottom nets and 359 trips fishing with handlines was proposed, corresponding approximately to the observed effort.

During the DELASS project (Heessen, 2003), a Bayesian stock assessment approach using the Pella-Tomlinson biomass dynamic model was applied to two fisheries, handline and bottom gill-net (ICES, 2003; 2005). Based on the probability of the Biomass 2001 be less than B_{MSY}, the stock was considered depleted.

4.9 Stock assessment

No new assessment was undertaken in 2021.

In the last assessment (2019), the ICES framework for category 6 was applied (ICES, 2012). For stocks without information on abundance or exploitation, ICES considers that a precautionary reduction of catches should be implemented unless there is ancillary information clearly indicating that the current level of exploitation is appropriate for the stock.

Landings have declined after the early 1990s, which is considered to be partly due to market conditions. In line with the zero TAC, landings have been negligible since 2010 and there are no new data to assess the status of the stock. In its most recent advice for 2020–2023, ICES advises that there should be no fisheries for this stock unless there is evidence that the fisheries will be sustainable..

4.10 Quality of assessments

No new assessment was undertaken.

4.11 Reference points

No reference points have been proposed for this stock.

4.12 Conservation considerations

Kitefin shark is listed as 'Vulnerable' on the IUCN Red List (Finucci *et al*., 2018)

4.13 Management considerations

Preliminary assessment results suggested that the stock might have been depleted to about 50% of virgin biomass. However, further analysis is required to better understand the actual status of the stock. Fisheries for kitefin shark have been affected by fluctuations in the price of shark liver oil. An analysis of liver oil prices may provide some information on historical exploitation levels of this species.

There are no adequate fishery-independent surveys to monitor the stock. WGEF recommends that the development of a fishery should not be permitted unless data on the level of sustainable catches become available. If an artisanal sentinel fishery is established, it should be accompanied by a data collection programme.

4.14 References

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Table 4.1. Kitefin shark in the Northeast Atlantic. Working Group estimates of landings (t) of kitefin shark *Dalatias licha*.

Country	Area	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
Germany	7j	5.9																5.9
	7k	15.1																15.1
France	27						1.2											1.2
	5b		1.3															1.3
	7b						0.1											0.1
	7e											0.0			0.3			0.3
	7g						0.0											0.0
	8a		0.5			0.0					0.0		0.0		0.0			0.5
	8b	1.1	1.4	1.0	0.8	0.2	0.4	0.6	0.0	0.0	0.0		0.1	0.0	0.1	0.0		5.7
	8c		0.1	0.0				0.1										0.2
UK	6a	19.1	24.5	1.8														45.5
	7b	0.4		0.3														0.7
	7c	11.3	0.3															11.7
	7j	26.4	3.7	1.3														31.4
	7k	32.3		1.0														33.3
	8c		0.7															0.7
	8d		0.1	0.2														0.3
	8e		1.5															1.5
	9b		4.2															4.2
Ireland	7b	0.0	0.4															0.4
	7c	4.6	5.3															9.9
	7j	0.4	0.7															1.2
	7k	2.2	2.3															4.5
	10	0.4																0.4
Portugal	9a	3.2	6.5	2.5	1.1	1.1	0.1	0.2	0.4	0.0	0.0		0.1	0.1	0.1	0.0	0.0	15.4
	10a	14.3	9.6	6.5	9.6	6.3	1.9	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		49.3
Total		136.9	63.1	14.7	11.5	7.5	3.7	1.9	0.4	0.0	0.0	0.0	0.3	0.1	0.5	0.0	0.0	240.8

Table 4.2. Kitefin shark in the Northeast Atlantic. Relative abundance of kitefin shark (number per hour trawling) from Scottish deep-water survey (depth range 500–1000 m: Only one fish has been caught outside this core depth range) in ICES Subarea 6.

Year	Nº hauls	Nº positive hauls	Nº fish	Mean Nph
1998	17	2	2	0.05
2000	13	0	0	0.00
2002	16	2	4	0.13
2004	14	2	2	0.07
2005	13	1	4	0.15
2006	20	3	8	0.20
2007	15	2	7	0.23
2008	20	3	5	0.13
2009	27	1	1	0.06
2011	15	1	1	0.07
2012	18	0	0	0.00
2013	11	1	1	0.09

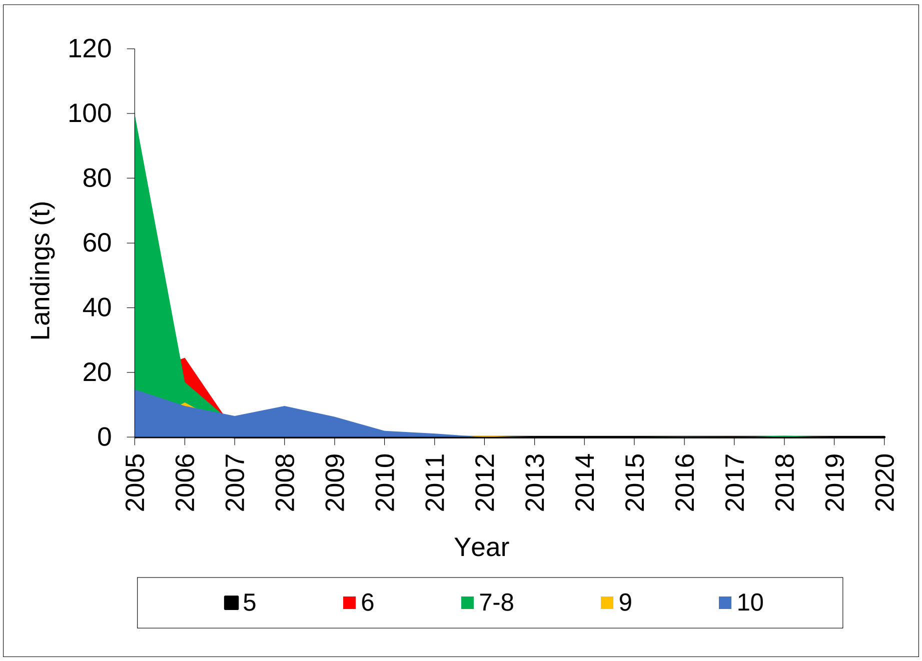

Figure 4.1. Kitefin shark in the Northeast Atlantic. Total landings of kitefin shark by ICES division.

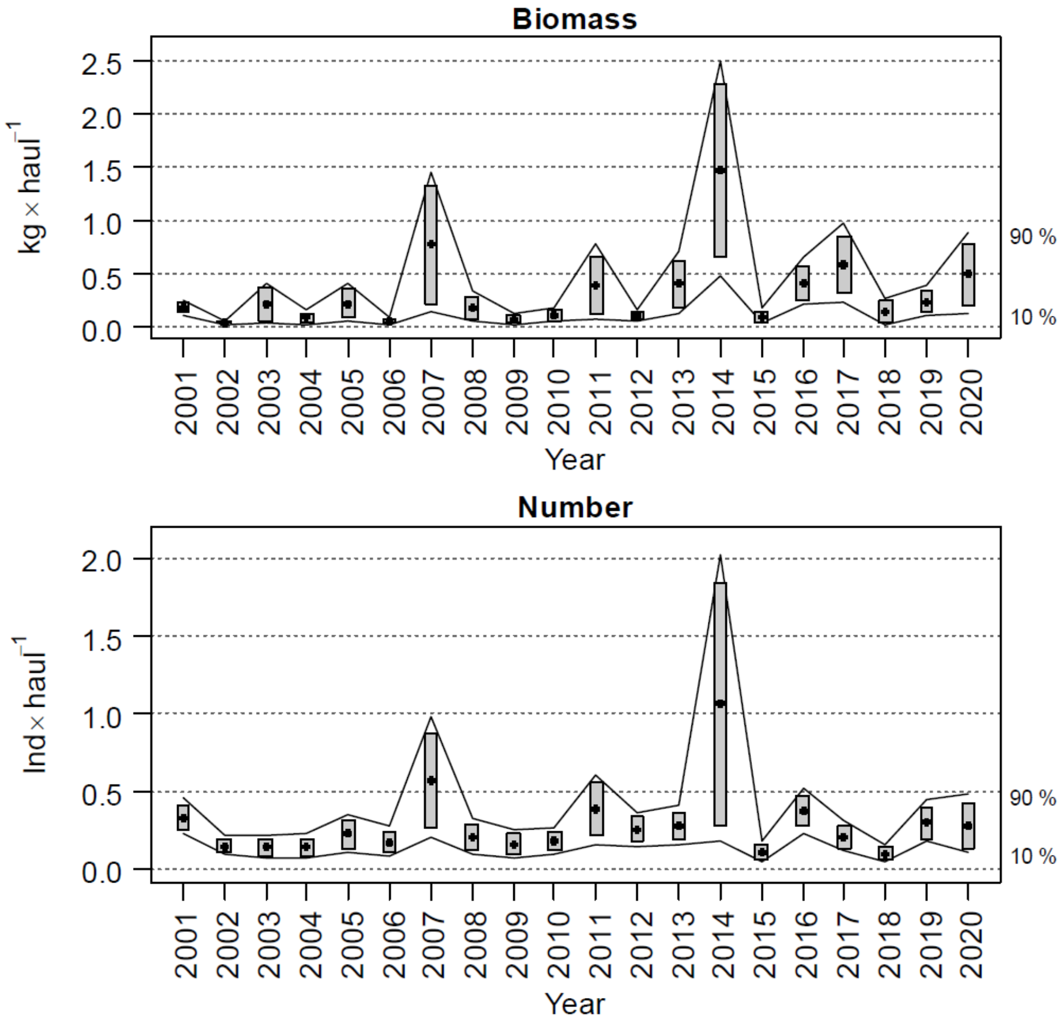

Figure 4.2. Kitefin shark in the Northeast Atlantic. Relative abundance of kitefin shark, in weight (kg/haul) and number from the Spanish groundfish survey on the Porcupine bank. Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000). Source: Fernández-Zapico *et al.* (2021 WD03).

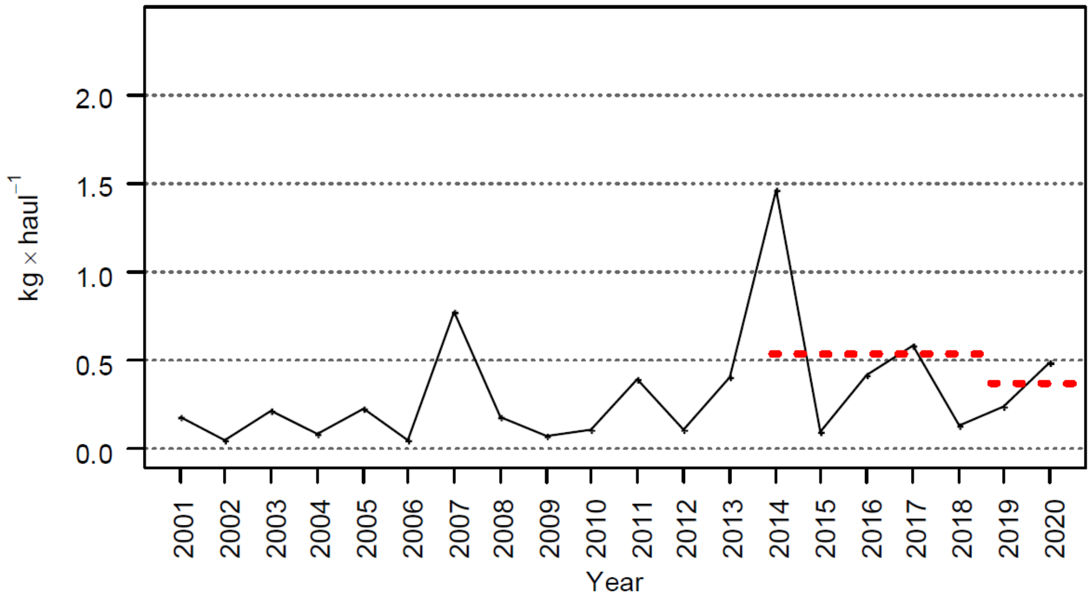

Figure 4.3. Evolution in kitefin shark biomass index in Porcupine surveys (2001–2020). Dotted red lines compare mean stratified biomass in the last two years (2019–2020) with the five previous years (2014–2018). Source: Fernández-Zapico *et al.* (2021 WD03).

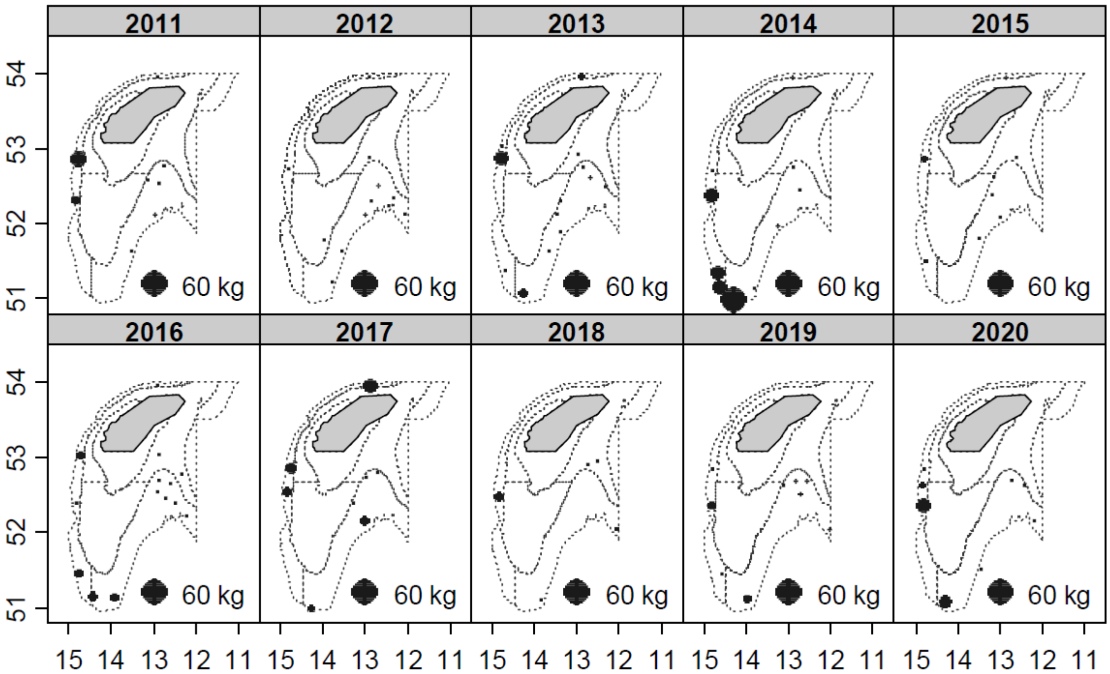

Figure 4.4. Kitefin shark in the Northeast Atlantic. Annual (2011–2020) spatial distribution of kitefin shark (kg/30 min haul) on the Porcupine bank survey. Source: Fernández-Zapico *et al.* (2021 WD03).

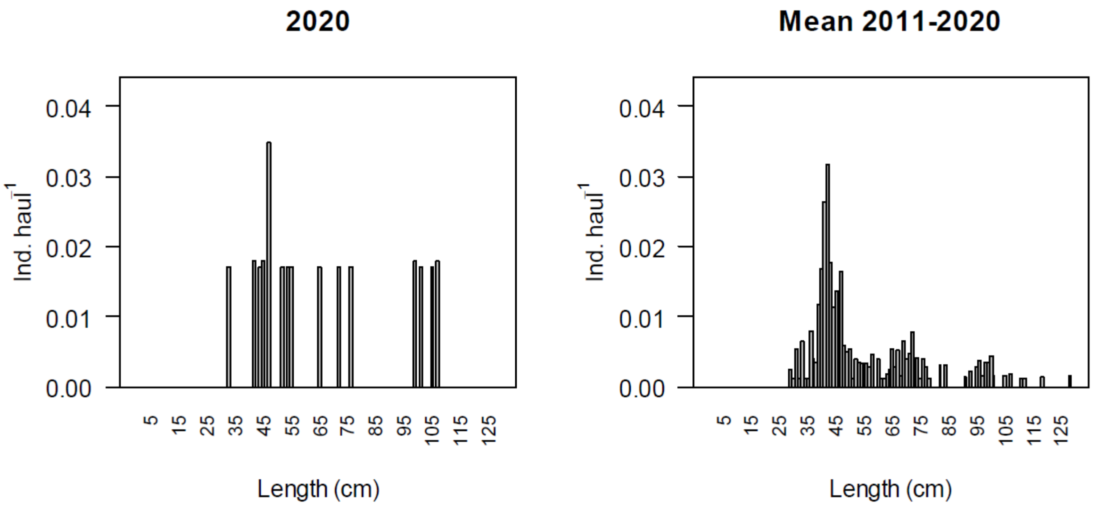

Figure 4.5. Kitefin shark in the Northeast Atlantic. Annual length composition of kitefin shark from the Spanish groundfish survey on the Porcupine Bank. Source: Fernández-Zapico *et al.* (2021 WD03).

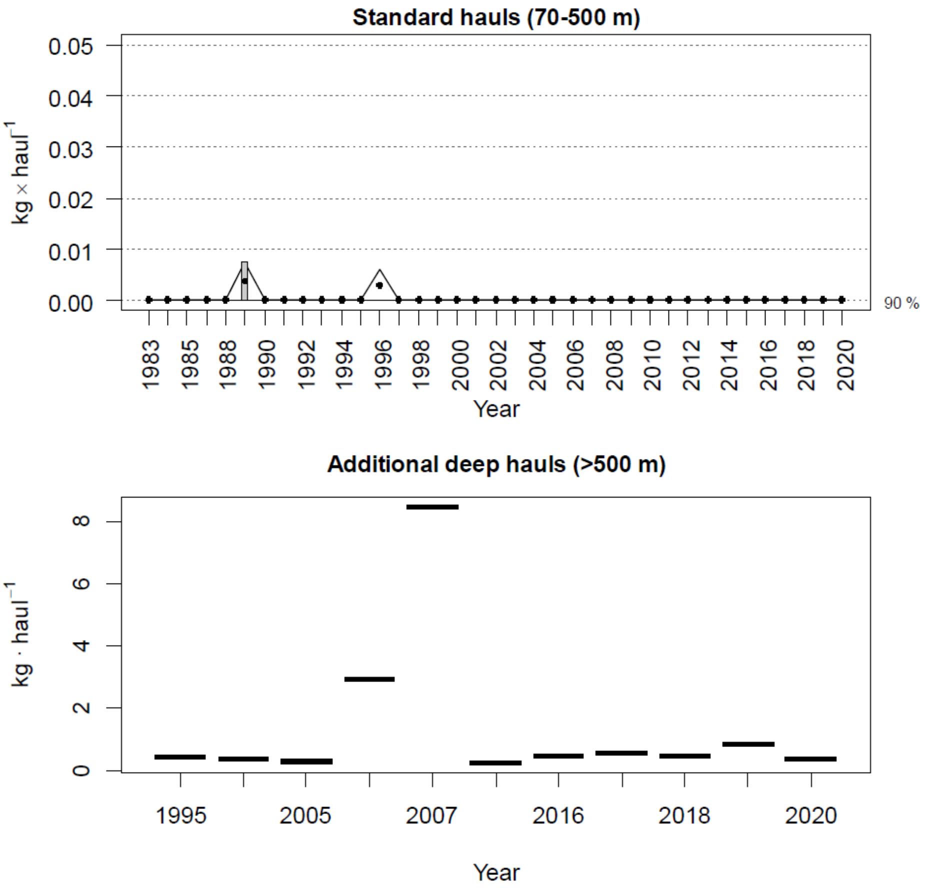

Figure 4.6. Kitefin shark in the Northern Spanish shelf. Relative abundance of kitefin shark in weight (kg/haul) from the Spanish bottom trawl survey in standard hauls (plot at the top) and in additional deep hauls (plot at the bottom). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000). Bottom figure boxplots of biomass considering only hauls with catches of *D. licha* in hauls out of the standard stratification (> 500 m) and not standardized to the area. Horizontal lines mark the median (and unique) value of the catch of the species in the year. Source: Fernández-Zapico *et al.* (2021 WD04).

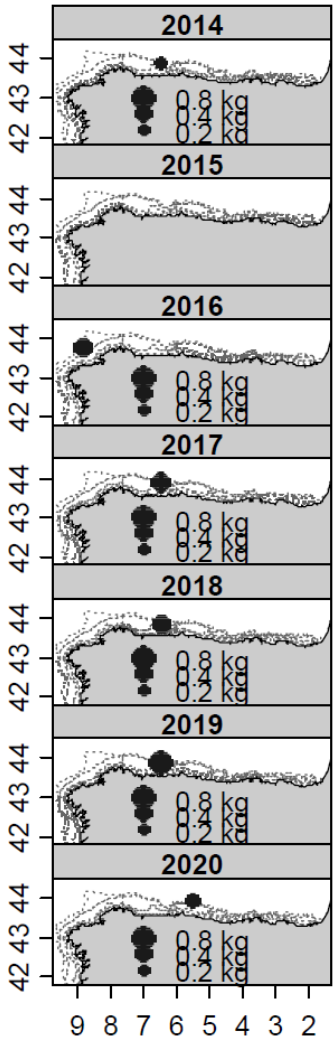

Figure 4.7. Kitefin shark in the Northern Spanish shelf. Annual (2014–2020) spatial distribution of kitefin shark (kg/30 min haul) from the Spanish bottom trawl survey. Source: Fernández-Zapico et al. (2021 WD04).

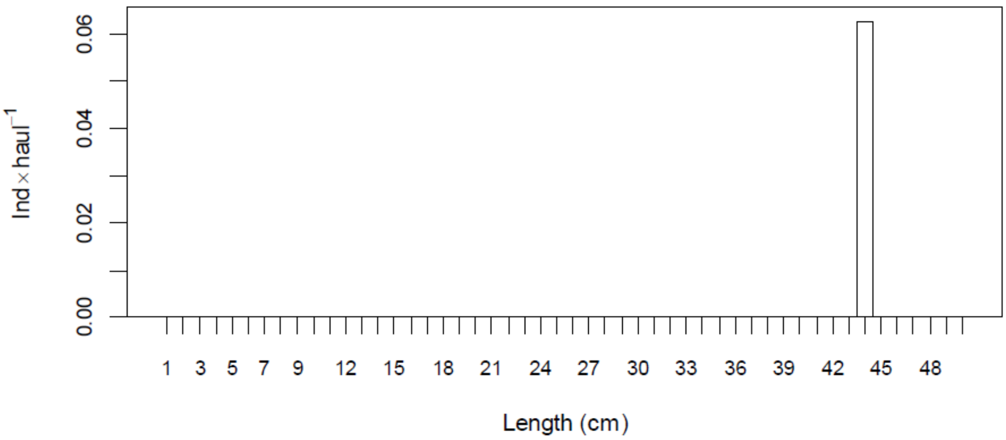

Figure 4.8. Kitefin shark in the Northern Spanish shelf. Annual length composition of kitefin shark from the Spanish bottom trawl survey in additional deep hauls (> 500 m) in 2020. Source: Fernández-Zapico *et al.* (2021 WD04).

5 Other deep-water sharks and skates from the Northeast Atlantic (ICES subareas 4–14)

5.1 Stock distributions

This section includes information about deep-water elasmobranch species other than Portuguese dogfish and leafscale gulper shark (see Section 3), kitefin shark (see Section 4) and Greenland shark (see Section 24). Limited information exists on the majority of the deep-water elasmobranchs considered here, and the stock units for these species are unknown.

The species and generic landing categories for which data are presented are: gulper sharks *Centrophorus* spp., birdbeak dogfish *Deania calcea*, longnose velvet dogfish *Centroscymnus crepidater*, black dogfish *Centroscyllium fabricii*, lanternsharks *nei Etmopterus* spp. Historical catches of knifetooth dogfish *Scymnodon ringens*, arrowhead dogfish *Deania profundorum*, bluntnose sixgill shark *Hexanchus griseus*, mouse catshark *Galeus murinus* velvet belly lanternshark *Etmopterus spinax* and 'aiguillat noir' (which may include *C. fabricii, C. crepidater* and *Etmopterus* spp.) are also presented in the stock annex. Other deep-water sharks in the ICES area include: deep-water catsharks *Apristurus* spp., frilled shark *Chlamydoselachus anguineus*, great lanternshark *Etmopterus princeps* and sailfin roughshark (sharpback shark) *Oxynotus paradoxus.*

Fifteen species of skate (Rajidae) are known from deep water in the NE Atlantic: Arctic skate *Amblyraja hyperborea*, Jensen's skate *Amblyraja jenseni*, Krefft's skate *Malacoraja kreffti*, roughskin skate *Malacoraja spinacidermis*, deep-water skate *Rajella bathyphila*, pallid skate *Bathyraja pallida*, Richardson's skate *Bathyraja richardsoni*, Bigelow's skate *Rajella bigelowi*, round skate *Rajella fyllae*, Mid-Atlantic skate *Rajella kukujevi*, spinytail skate *Bathyraja spinicauda*, sailray *Rajella lintea*, Norwegian skate *Dipturus nidarosiensis,* blue pygmy skate *Neoraja caerulea* and Iberian pygmy skate *Neoraja iberica*.

Species such as common skate complex, shagreen skate *Leucoraja fullonica*, starry ray *Amblyraja radiata* and longnose skate *Dipturus oxyrinchus* also distributed in shallower waters down to 500 m and are not considered in this section. The electric ray *Torpedo nobiliana* may also occur in deep waters.

Eight species of rabbitfish (Chondichthyes; Holocephali), including members of the genera *Chimaera, Hariotta* and *Rhinochimaera* are a bycatch of some deep-water fisheries and are sometimes marketed. The current zero-TACs for deep-water sharks, whose livers were used to extract squalene, may have led to the increased retention of rabbitfish, particularly common chimaera *Chimaera monstrosa* in Norway to produce "ratfish oil". Catches of Chimaeridae are included in the report of the ICES Working Group on the Biology and Assessment of Deep-sea Fisheries Resources (WGDEEP).

5.2 The fishery

5.2.1 History of the fishery

Most species of other deep-water shark and skate species are taken as by-catch in mixed trawl, longline and gillnet fisheries together with Portuguese dogfish, leafscale gulper shark and deep-water teleosts.

5.2.2 The fishery in 2020

Deep-water elasmobranch species were taken as bycatch in mixed fisheries.

Since 2010, EU TACs for deep-water sharks have been set at zero (see Section 5.2.4) and consequently, reported landings of most of the species covered in this chapter were very low or zero in 2020. As a consequence of this Regulation, it is likely that discarding has increased.

As a consequence of the Council Regulation (EU) 2016/2285, which fixed a restrictive by-catch of deep-sea sharks of 10 tonnes in 2017–2018 and 7 tonnes in 2019–2020 in directed artisanal deep-sea longline fisheries for black scabbardfish, some landings attributed to Portuguese waters are reported from 2017 to 2020.

5.2.3 ICES advice applicable

No species-specific advice is given for the shark and skate species considered here.

5.2.4 Management applicable

The EU TACs that have been adopted for deep-sea sharks in European Community waters and international waters at different ICES subareas are summarized below.

Year	ICES subareas		
	5–9	10	12 (includes also *Deania histricosa* and *Deania profondorum)* (5)
2005 and 2006	6763	14	243
2007	2472(1)	20	99
2008	1646(1)	20	49
2009	824(1)	10(1)	25(1)
2010	0(2)	0(2)	0(2)
2011	0(3)	0(3)	0(3)
2012	0	0	0
2013	0	0	0
2014	0	0	0
2015	0	0	0
2016	0	0	0
2017	10(4)	10(4)	0
2018	10(4)	10(4)	0
2019	7(4)	7(4)	0
2020	7(4)	7(4)	0

(1) Bycatch only. No directed fisheries for deep-sea sharks are permitted.

(2) Bycatch of up to 10% of 2009 quotas is permitted.

(3) Bycatch of up to 3% of 2009 quotas is permitted.

(4) Exclusively for bycatch in longline fishery targeting black scabbardfish. No directed fishery shall be permitted.

(5) Recent studies demonstrated that there is not enough scientific support to discriminate *Deania hystricosa* from its congener *Deania calcea*; they are likely the same species (Rodríguez-Cabello *et al.*, 2020; Stefanni *et al.*, 2021)

Since 2013, the deep-sea shark category includes the following species (Council regulation (EC) No 1182/2013): Deep-water catsharks *Apristurus spp*., frilled shark *Chlamydoselachus anguineus*, gulper sharks *Centrophorus spp*., Portuguese dogfish *Centroscymnus coelolepis*, longnose velvet dogfish *Centroscymnus crepidater*, black dogfish *Centroscyllium fabricii*; birdbeak dogfish *Deania calcea*; kitefin shark *Dalatias licha*; greater lantern shark *Etmopterus princeps*; velvet belly *Etmopterus spinax*; mouse catshark *Galeus murinus*; six-gilled shark *Hexanchus griseus*; sailfin roughshark *Oxynotus paradoxus*; knifetooth dogfish *Scymnodon ringens* and Greenland shark *Somniosus microcephalus*.

Since 2013, under NEAFC Recommendation 7, it was required that Contracting Parties prohibit vessels flying their flag in the Regulatory Area from directed fishing for deep-sea sharks on the following list: *Centrophorus granulosus, Centrophorus squamosus, Centroscyllium fabricii, Centroscymnus coelolepis, Centroscymnus crepidater, Dalatias licha, Etmopterus princeps, Apristurus* spp., *Chlamydoselachus anguineus, Deania calcea, Galeus melastomus, Galeus murinus, Hexanchus griseus, Etmopterus spinax, Oxynotus paradoxus, Scymnodon ringens* and *Somniosus microcephalus*.

In 2005, the use of trawls and gillnets in waters deeper than 200 m in the Azores, Madeira and Canary Island areas was banned (Council Regulation (EC) No 1568/2005). In 2007, the use of gillnets by Community vessels at depths greater than 600 m in ICES divisions 6.a-b, 7.b-c, 7.j-k and Subarea 12 was banned while a maximum bycatch of deep-water shark of 5% in hake and monkfish gillnet catches was allowed (Council Regulation (EC) No 41/2007). A gillnet ban in waters deeper than 200 m is also in operation in the NEAFC regulatory Area (all international waters of the ICES Area). NEAFC also ordered the removal of all such nets from NEAFC waters by 1 February 2006.

Since 2009, the "rasco (gillnet)" fishing gear was banned at depths lower than the 600 m isobath (EC Regulation 43/2009,). The regulation affected 4–6 boats in the Basque Country that used this technique. The "rasco" fleet targets anglerfish *Lophius spp*., which represents around 90% of catch weight. This métier is highly seasonal, with the highest activity occurring during winter months. Catches during these months tend to occur in deeper waters, where the nets are sunk to depths down to 1000 m.

Since 2016, and in order to mitigate the potential damaging impacts of bottom trawling, fishing with bottom trawls was permitted only at, or above, a depth of 800 metres (EU Regulation 2016/2336).

A by-catch TAC for deep-water sharks was allowed for each of the years from 2017 to 2020, on a trial basis, in the directed artisanal deep-sea longline fisheries for black scabbardfish (Council regulation (EU) 2016/2285; Council regulation (EU) 2018/2025). According to this limited landing of unavoidable by-catches of deep-sea sharks were allowed and Member States should develop regional management measures for the black scabbardfish fishery and establish specific data-collection measures for deep-sea sharks to ensure their close monitoring. Specifically, 10 and 7 tonnes were allowed for deep-sea sharks in Union and international waters of ICES subareas 5, 6, 7, 8 and 9, in Union and international waters of ICES Subarea 10 and in Union waters of CECAF 34.1.1, 34.1.2 and 34. 2 in 2017–2018 and 2019–2020, respectively. This allowance was in accordance with ICES indications according to which in the artisanal deep-sea longline fisheries for black scabbardfish, the restrictive catch limits lead to misreporting of unavoidable by-catches of deep-sea sharks, which are currently discarded dead.

The Council regulation (EU) 2016/2285 affects specifically the Portuguese deep-water longline fishery targeting black scabbardfish in ICES Division 9.a and Subarea 10. As a response Portugal has proposed an action plan focusing the black scabbardfish fishery and this plan is coordinated by the Portuguese General Directorate of Fisheries. Among other objectives, under this plan different management strategies were expected to be evaluated.

The council regulation (EU) 2021/91 fixing, for the years 2021 and 2022, the fishing opportunities for Union fishing vessels for certain deep-sea fish stocks, prohibits to fish for deep-sea sharks in ICES subareas 5 to 9, in Union and international waters of ICES subarea 10, in international waters of ICES subarea 12 and in Union waters of CECAF areas 34.1.1, 34.1.2 and 34.2, and to retain on board, tranship, relocate or land deep-sea sharks caught in those areas, with no exceptions.

5.3 Catch data

5.3.1 Landings

Landings estimates from 2005 onwards were revised following WKSHARK2 (updated in WGEF 2018). Information, by species, is presented below. Past information is presented in the stock annex. Due to the management measures in force for deep-water sharks their landings in 2020 continued to be low (tables 5.1–5.8).

Gulper sharks *Centrophorus* spp. (excluding *C. squamosus*)

WGEF landings estimates of gulper sharks are presented in tables 5.1 and 5.7.

In 2020, under the 7 tonnes TAC, 0.5 tonnes were landed by the Portuguese deep-water longline fleet.

Birdbeak dogfish *Deania calcea*

WGEF landings estimates of birdbeak dogfish are presented in tables 5.2 and 5.7.

Five European countries reported landings of birdbeak dogfish: Norway, Ireland, UK, Spain and Portugal. In 2020, under the 7 tonnes EU TAC, 1.8 tonnes were landed by the Portuguese deep-water longline fleet. Landings < 0.1 were also reported by Norway in 2020.

Longnose velvet dogfish *Centroscymnus crepidater*

WGEF landings estimates of longnose velvet dogfish are presented in tables 5.3 and 5.7.

In 2020, under the 7 tonnes TAC, 0.2 tonnes were landed by the Portuguese deep-water longline fleet.

Black dogfish *Centroscyllium fabricii*

Reported landings of black dogfish are presented in tables 5.4 and 5.7.

A total of 0.2 tonnes were reported by Iceland in 2020.

Lanternsharks *Etmopterus* spp.

Reported landings of velvet belly lanternshark *Etmopterus spinax* are presented in Table 5.5 until 2004. Revised landing data provided to WGEF from 2005 onwards indicates that landings assigned to *E. spinax* should be considered as *Etmopterus* spp. Those figures are provided in tables 5.6 and 5.7. Six countries have reported landings of *Etmopterus* spp.: Denmark, Norway, UK, France, Spain and Portugal. Until 2001, the greatest landings were from Denmark. Norway reported 171 tonnes in 2020, the highest value reported of *Etmopterus* spp.

Portuguese landings mainly referred to *Etmopterus spinax* and *Etmopterus pusillus*, however, only a very small proportion of the catches of these species is retained.

Catches of this species by Russian deep-water longline fisheries in the Faroese Fishing Zone and other Northeastern Atlantic areas were reported in working documents to WGEF (Vinnichenko and Fomin, 2009 WD; Vinnichenko *et al*., 2010 WD). Landings data from this fishery were not subsequently available to the working group.

Other species

There are landings information for other deep-water shark species, presented in Table 5.7. Other reported landings are sporadic and very low and thus were not presented.

5.3.2 Discards

Historical discards from Portugal (Azores and mainland) and Spain are available in the stock annex.

Ireland: Discard data from Ireland is available since 2009 from the trawl fleet operating in ICES divisions 27.6.a and 27.7.bgj (Table 5.8). Discards are considered negligible as values estimated are <1 tonne in most of the years.

Denmark: Discard data from *E. spinax* is available from 2009 to 2017 (Table 5.8). This species is mostly discarded by the trawl fleet from areas 27.3.a, 27.4.a and 27.4.b. Discards varied among years but has remained around 5–6 tonnes in 2016 and 2017.

Sweden: Discard data from *E. spinax* is available for 2019 (Table 5.8).

5.3.3 Quality of the catch data

Data provided to WGEF since 2017 followed WKSHARK2 guidelines. Despite the decisions taken regarding the assignment of landings to species or higher *taxa* some problems persist. For example, some quantities of deep-water species are maintained grouped in generic categories such as “sharks indetermined”, “unidentified deepwater sharks” or “Squaliformes”.

Irish discard values (2009–2020) were updated in 2021.

As result of restrictive quotas for deep-water sharks, landings of these species may have been misidentified.

5.3.4 Discard survival

No data available to the Working Group.

5.4 Commercial catch composition

No new information is available.

5.5 Commercial catch and effort data

No new information is available.

5.6 Fishery-independent surveys

5.6.1 ICES Subarea 6

The Scottish deep-water trawl survey has operated from 1996 to 2017 at depths of 300–2000 m along the continental slope between approximately 55°N and 59°N (see Neat *et al*. (2010) for details). Neat *et al*. (2015) analysed catches of deep-water elasmobranch species from Scottish deep-water trawl survey.

5.6.2 ICES Subarea 7

The Spanish survey on the Porcupine Bank (SpPGFS-WIBTS-Q4) in ICES divisions 7.c and 7.k covers an area from longitude 12°W to 15°W and from latitude 51°N to 54°N following the standard IBTS methodology for the western and southern areas (ICES, 2010). The sampling design is a random stratified (Velasco and Serrano, 2003) with two geographical sectors (North and South) and three depth strata (<300 m, 300–450 m and 450–800 m). Haul allocation is proportional to the strata area following a buffered random sampling procedure (as proposed by Kingsley *et al*., 2004) to avoid the selection of adjacent 5×5 nm rectangles. More details on the survey design and methodology are presented in ICES (2017). In 2019, elasmobranchs constituted ~8% of that total fish caught. Results for 2020 are presented in Fernández-Zapico *et al*. (WD03 2021a). The most abundant deep-water shark species in biomass in these surveys are *D. calcea* (birdbeak dogfish), *S. ringens* (knifetooth dogfish), *E. spinax* (velvet belly lantern shark), *D. licha* (kitefin shark), and *H. griseus* (bluntnose six-gill shark). Length distributions for these species are presented in the working document presented to WGEF (see Fernández-Zapico *et al*., WD03 2021a).

5.6.3 ICES divisions 8.c and 9.a

From 2015 to 2019, AZTI conducted a deep-water longline survey (PALPROF) along the Basque Coast (600–2400 m deep) onboard a commercial longliner, with the objective of estimating and assessing the inter-annual variation of the abundance and biomass indices of the deep-water sharks and other ichthyofauna (Diez *et al*., WD01 2021). More information is presented in Section 3.9.2. from Section 3 (3. Deep-water sharks; Leafscale gulper shark and Portuguese dogfish in the Northeast Atlantic (subareas 4–14)).

The Spanish survey in the Cantabrian Sea and Galician waters (SpGFS-WIBTS-Q4) has covered this area annually since 1983 (except 1987), obtaining abundance indices and length distributions for the main commercial species and elasmobranchs. A new vessel (R/V Miguel Oliver) is in use since 2013. More details on the survey design, methodology and results can be found in ICES (2017). In 2020, elasmobranchs represented 11% of the total fish caught (Fernández-Zapico *et al*., WD04 2021b). Length distribution for the most abundant species are presented in the working document presented to WGEF (see WD04 - Fernández-Zapico *et al*., 2021b).

In the Portuguese survey (PtGFS-WIBTS-Q4) taking place off southwestern and southern coasts, the deep-water elasmobranchs with highest catches are *E. spinax* and *D. profundorum*. This survey is designed for crustacean species and operates to depths of 700 m.

5.6.4 ICES Subarea 10

Data from the Azorean bottom longline survey (ARQDACO(P)-Q1) in Division 10.a2 were given in Pinho and Silva (2017, WD). *Deania* spp. were the most representative (abundant) species in the survey. *Centroscymnus crepidater* was common, but much less abundant. Other species occurred in very low numbers (averaging 1–4 individuals per year). Depth range sand length composition data are available. It should be noted that the gear configuration used is not adequate for sampling all the species (Pinho and Silva, 2017 WD).

5.7 Life-history information

See Stock annex for further details.

5.8 Exploratory assessments analyses of relative abundance indices

The exploratory assessments below are all based on analyses of relative abundance or biomass indices in fishery-independent surveys.

Information previously submitted to WGEF for the black dogfish *C. fabricii,* the longnose velvet dogfish *C. crepidater,* the greater lantern shark *E. princeps,* the small-eye catshark *A. microps,* the pale catshark *A. aphyodes* and other deep-water skates and rays are presented in the stock annex.

5.8.1 Summary of trends by species

Birdbeak dogfish *Deania calcea* and Arrowhead dogfish *Deania profundorum*

In the SpPGFS-WIBTS-Q4 survey series, these two species were traditionally registered together, but have been better separated since 2012. The biomass and abundance of *Deania* spp. (mainly *D. calcea*) have followed a downward trend since 2016 but increased in 2020 to values close to 2018 (Figure 5.1). The biomass and abundance of *D. profundorum* were negligible (Fernández-Zapico *et al*., WD03 2021a).

In the SpGFS-WIBTS-Q4, both species are more frequent in additional deeper hauls (>500 m) and scarce or absent on the standard hauls (70–500 m) (Figure 5.2). After two years without records, *Deania calcea* was captured again in 2019 and 2020 with a biomass quite higher than the value recorded in 2016. The biomass of *D. profundorum* increased in relation to the previous years (Fernández-Zapico *et al*., WD04 2021b).

This species has been caught by the PALPROF survey in ICES Division 8.c (2015–2019). The species is frequent (the second more abundant species in most of the years) and the CPUE values are variable, showing no trend (Figure 5.3) (Diez *et al*., WD01 2021).

Knifetooth dogfish *Scymnodon ringens*

In the Spanish Porcupine survey (SpPGFS-WIBTS-Q4) the biomass and abundance of *S. ringens* increased in 2020 (Figure 5.4) (Fernández-Zapico *et al*., WD03 2021a). Since 2006 that the values fluctuated with no evident trend.

Biomass values of this species in the SpGFS-WIBTS-Q4 survey in the Cantabrian Sea and Galician waters are very low. This species is mostly caught in the additional deeper hauls. In these, biomass have fluctuated with no evident trend (Figure 5.5) (Fernández-Zapico *et al*., WD04 2021b).

Velvet belly lanternshark *Etmopterus spinax*

Although the abundance of ***E. spinax*** increased in 2020, the biomass decreased compared to the previous year. The values have been following an up and down trend throughout the time series, without any trend (Figure 5.6; Fernández-Zapico *et al.*, WD03 2021a).

In the SpGFS-WIBTS-Q4 survey in the Cantabrian Sea and Galician waters the biomass increased substantially in standard hauls in 2020, corresponding to the highest value in the time series (Figure 5.7). A high fraction of the biomass of this elasmobranch is usually found in hauls deeper than 500 m (Fernández-Zapico *et al.*, WD04 2021b). In the additional deep hauls, the mean biomass of this species remained close to the values observed in the last years.

Bluntnose six-gill shark *Hexanchus griseus*

The stratified biomass index of *H. griseus* in the Spanish Porcupine survey (SpPGFS-WIBTS-Q4) increased in 2020 but the abundance decreased. The overall series present no trend, being more or less stable along the years (Figure 5.8) (Fernández-Zapico *et al*., WD03 2021a).

In the SpGFS-WIBTS-Q4 survey in the Cantabrian Sea and Galician waters, the biomass of *H. griseus* in 2020 decreased in standard hauls but the value is still among the highest of the time series (Figure 5.9). Comparatively to 2019, the biomass increased in the additional deep hauls (Fernández-Zapico *et al*., WD04 2021b).

Other deep-water elasmobranchs

In 2020, *Dipturus nidarosiensis* were caught in eight hauls of the Spanish Porcupine survey (SpPGFS-WIBTS-Q4) (Fernández-Zapico *et al*., WD03 2021a).

Etmopterus pusillus and *Centroscymnus crepidater*, were caught in low numbers in the SpGFS-WIBTS-Q4 survey conducted in 2020 in the Cantabrian Sea and Galician waters (Fernández-Zapico *et al*., WD04 2021b).

Centroscymnus crepidater and *Etmopterus princeps* were caught in the PALPROF survey in ICES Subdivision 8.c and CPUE data is available for the period 2015–2020 (Figure 5.3) (Diez *et al*., WD01 2020).

5.9 Stock assessment

No formal assessments are undertaken for these stocks.

5.10 Quality of assessments

No assessments undertaken.

5.11 Reference points

No reference points have been proposed for any of the species.

5.12 Conservation considerations

The European Red List of marine fishes considers *C. granulosus* to be Critically Endangered, *Echinorhinus brucus*, *D. calcea* and *D. nidarosiensis* as Endangered; and *Centrophorus uyato* and *Oxynotus centrina* as Vulnerable (Nieto *et al*., 2015).

Recent IUCN assessments for a group of deep-water sharks classified *C. crepidater*, *D. profundorum*, *D. calcea* and *H. griseus* as globally Near Threatened, *S. ringens* as globally Vulnerable, *C. granulosus*, *C. uyato* and *E. brucus* as globally Endangered. All these species were considered to have their populations stable or increasing in the NE Atlantic (Finucci *et al*. 2020a, b, c, d, e, f, g).

5.13 Management considerations

No management advice is given in 2020.

5.14 References

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Table 5.1. Other deep-water sharks and skates from the Northeast Atlantic. Working Group estimates of landings of gulper sharks (*Centrophorus granulosus* and *Centrophorus* spp.) in tonnes. Portuguese landings (1) are assigned to *Centrophorus* spp. (not *C. squamosus*) whereas Irish landings (2) are assigned to *C. granulosus*. Estimates from 2005 onwards were revised following WKSHARK2.

	UK	Portugal[1]	Spain	Ireland[2]	Total
1990		1056			1056
1991		801			801
1992		958			958
1993		886			886
1994		344			344
1995		423			423
1996		242			242
1997		291			291
1998		187			187
1999		95			95
2000		54			54
2001		96			96
2002		159	8		167
2003	643	203			846
2004	481	89	n.a.		570
2005		49	n.a.	14	64
2006		100			100
2007		62			62
2008		56			56
2009		17			17
2010		7			7
2011		2	+		2
2012		1			1
2013		+			+
2014		+			+
2015		+			+
2016		+			+
2017		2			2
2018		4			4
2019		+			+
2020		0.5			0.5

+ = catch under 0.5 tonnes

Table 5.2. Other deep-water sharks and skates from the Northeast Atlantic. Working Group estimates of landings of birdbeak dogfish (*Deania calcea*), in tonnes. Estimates from 2005 onwards were revised following WKSHARK2.

	Ireland	Spain	UK	France	Portugal	Norway	Total
1990							
1991							
1992							
1993							
1994							
1995							
1996							
1997							
1998							
1999							
2000					13		13
2001			1		37		38
2002		5	+		67		72
2003		n.a.	3		72		75
2004		n.a.	38		157		195
2005			50		146		195
2006			22		75		96
2007					37		37
2008				5	57		62
2009				2	22		25
2010				+	3		3
2011					1		1
2012	2				1		3
2013					0	+	+
2014						+	+
2015					0	+	+
2016						+	+
2017					2	+	3
2018					1	+	1
2019					5	+	5
2020					2	+	2

+ = catch under 0.5 tonnes

Table 5.3. Other deep-water sharks and skates from the Northeast Atlantic. Working Group estimates of landings of longnose velvet dogfish (*Centroscymnus crepidater*), in tonnes. Estimates from 2005 onwards were revised following WKSHARK2.

	France	Ireland	UK	Portugal	Spain	Total
1990						
1991						
1992						
1993						
1994						
1995						
1996						
1997						
1998						
1999	+		+			+
2000	+		+	1	85	86
2001	+		+	3	68	71
2002	13		+	4	n.a.	17
2003	10		21	2	n.a.	33
2004	8		7	1	n.a.	16
2005	10		209	3		222
2006	4		409	7		420
2007	2	2	109	18		131
2008	4			33		37
2009	6			27		33
2010	40			+		40
2011						
2012						
2013						
2014				+		+
2015				+		+
2016	+			+		+
2017				1		1
2018				1		1
2019				1		1
2020				+		+

+ = catch under 0.5 tonnes

Table 5.4. Other deep-water sharks and skates from the Northeast Atlantic. Working Group estimates of landings of black dogfish (*Centroscyllium fabricii*), in tonnes. Estimates from 2005 onwards were revised following WKSHARK2.

	France	Iceland	UK	Spain	Total
1990					
1991					
1992		1			
1993					
1994					
1995		1			
1996		4			
1997					
1998					
1999	+				
2000	382			85	467
2001	395			91	486
2002	47	+		n.a.	47
2003	90	+	+	n.a.	90
2004	49	n.a.	+	n.a.	49
2005	12		5		17
2006	3				3
2007	6				6
2008	136				136
2009	99	1			101
2010	85	10			95
2011	+	1			1
2012	1	3			3
2013	+	1			1
2014	9	+			9
2015	+	2			2
2016	+	+			+
2017					+
2018					
2019					
2020		+			+

+ = catch under 0.5 tonnes

Table 5.5. Other deep-water sharks and skates from the Northeast Atlantic. Working Group estimates of landings of velvet belly lanternshark (*Etmopterus spinax*), in tonnes.

	Norway	Denmark	Spain	France	Total
1990					
1991					
1992					
1993		27			27
1994		+			+
1995		10			10
1996		8			8
1997		32			32
1998		359			359
1999		128			128
2000		25			25
2001		52			52
2002			85		85
2003					
2004					

Table 5.6. Other deep-water sharks and skates from the Northeast Atlantic. Working Group estimates of landings of *Etmopterus* spp, in tonnes. Estimates from 2005 onwards were revised following WKSHARK2.

	Denmark	Norway	France	Spain	Portugal	UK	total
1990							
1991							
1992							
1993							
1994			846		+		846
1995			2388		+		2388
1996			2888		+		2888
1997			2150		+		2150
1998			2043				2043
1999			+				+
2000			+	38	+		38
2001			+	338			338
2002			+	99			99
2003			+				+
2004			+		+		+
2005	16			2	+	9	27
2006	17			27	+		44
2007	9			87		8	103
2008	46		+	6		20	72
2009			1	9			9

	Denmark	Norway	France	Spain	Portugal	UK	total
2010	4	9	2				15
2011		4	1	1*	+	+	5
2012		13	+	2*	+		13
2013		19	+			+	19
2014		47				+	47
2015		27	1		+	+	28
2016		59	+				59
2017		129	+				129
2018		106**				4**	110
2019		163**				7**	170
2020		171**					171

*** assigned to *Etmopterus pusillus***
*** * assigned to *Etmopterus spinax***

Table 5.7. Other deep-water sharks and skates from the Northeast Atlantic. Working Group estimates of landings by species since 2005, after revision following WKSHARK2 (in tonnes), (DWS = Unspecified deep-water sharks).

Species	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Gulper shark	64	100	62	56	17	7	2	1	+	+	+	+	2	4	+	1
Centroscymnus spp.	545	514	699	537	384											
Birdbeak dogfish	195	96	37	62	25	3	1	3	+	+	+	+	3	1	5	2
Longnose velvet dogfish	222	420	131	37	33	40				+	+	+	1	1	1	+
Black dogfish	17	3	6	136	101	95	1	3	1	9	2	+				+
Lanternsharks	27	44	103	72	9	15	5	13	19	47	28	59	129	110	170	171
Knifetooth dogfish	65	56	161	156	36	53	2	3	+	+						
Arrowhead dogfish			1		+	1	2	1			+		1			
Bluntnose sixgill shark	13	13	54	2	5	2	2	1	2	+	1	+				+
Mouse catshark			+	+	3	2	5	1	4	4	2	3				
Unidentified DWS*	110	62	111	51	37	40	42	175	89	118	85	91	131	150	168	155

*** Also allocated to “Squaliformes” and “unidentified deep-water squaloid sharks and dogfishes”**

Table 5.8. Other deep-water sharks and skates from the Northeast Atlantic. Discards estimates from Ireland and Denmark (in tonnes). Unspec. DWS = Unspecified deep-water sharks.

Year	Ireland						Denmark	Sweden
	C. fabricii	*E. princeps*	*H. griseus*	*E. spinax*	Unspec. DWS	*D. nidarosienesis*	*Etmopterus* spp,	*Etmopterus* spp.
2009		0.97				0.29	23.49	
2010	3.05					0.74	146.61	
2011		0.01				2.14	50.70	
2012		0.04					16.34	
2013						2.13	24.82	
2014						0.90	3.63	
2015	1.50	3.24				0.40	34.30	
2016	12.06	0.68		0.34	5.40	5.40	5.54	
2017	0.17					42.30	5.41	
2018			5.83	5.83		1.42		
2019				0.07				12.72
2020				1.07				

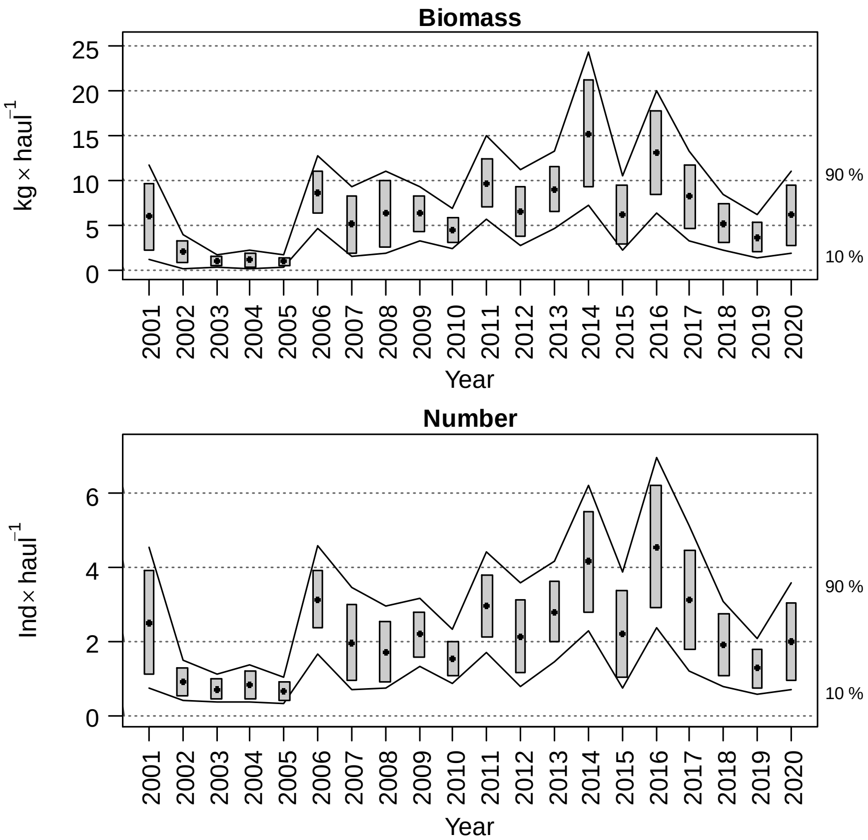

Figure 5.1. Other deep-water sharks and skates from the Northeast Atlantic. *Deania* spp., mainly birdbeak dogfish *Deania calcea* biomass index (kg haul^{-1}) from the Spanish Porcupine survey time-series (SpPGFS-WIBTS-Q4, 2001–2019). Boxes show parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000). From Fernández-Zapico *et al.* (WD03 2021a).

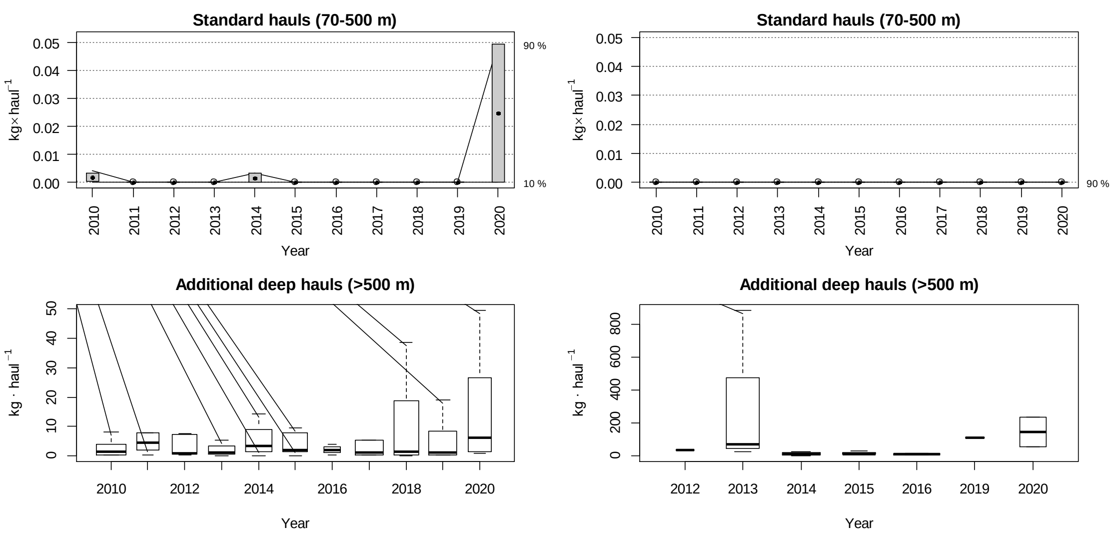

Figure 5.2. Other deep-water sharks and skates from the Northeast Atlantic. Evolution of *Deania profundorum* and *Deania calcea* stratified biomass index in standard hauls and in additional deep hauls during the North Spanish shelf bottom trawl survey time series (SpGFS-WIBTS-Q4, 2009–2019). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α = 0.80, bootstrap iterations = 1000). From Fernández-Zapico *et al.* (WD03 2021b).

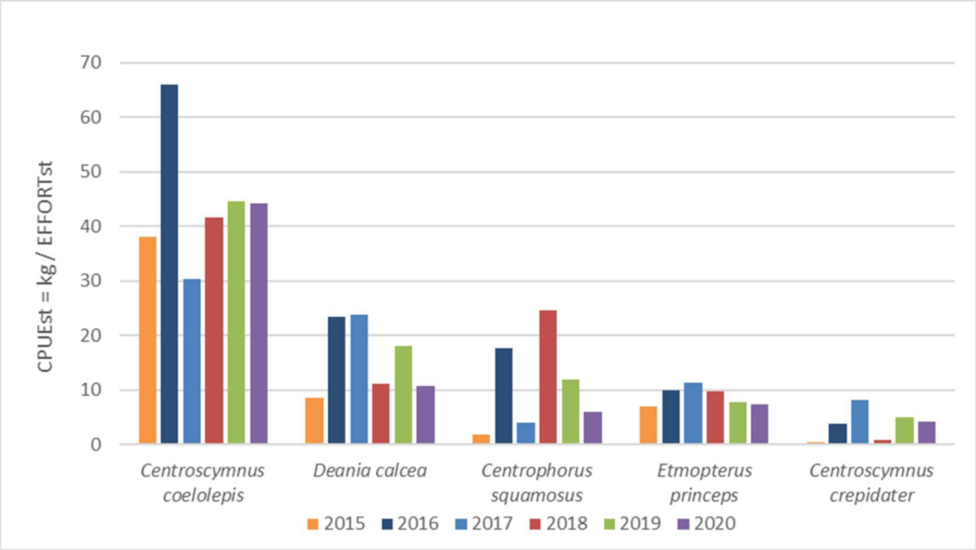

Figure 5.3. Other deep-water sharks and skates from the Northeast Atlantic. CPUE of the five main deep-water sharks caught by the PALPROF survey conducted in the coast along the Basque Country in the period 2015–2019. Results for *Deania calcea*, *Etmopterus princeps* and *Centroscymnus crepidater*. From Diez *et al.* (WD01 2021)

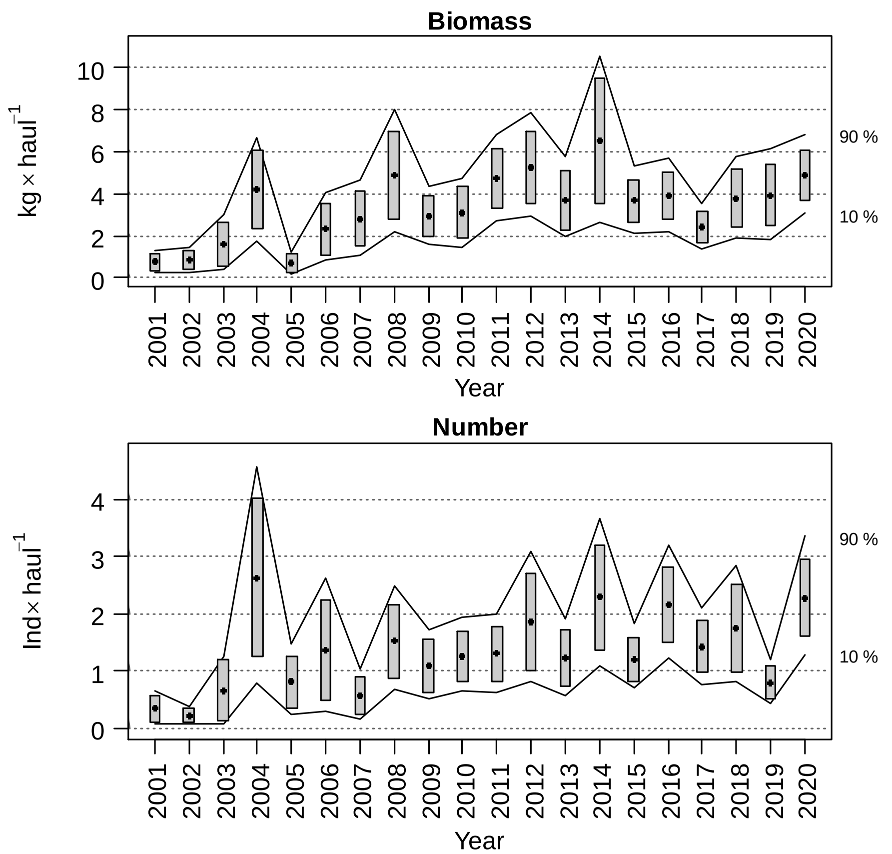

Figure 5.4. Other deep-water sharks and skates from the Northeast Atlantic. Knifetooth dogfish *Scymnodon ringens* biomass index (top, kg haul^{-1}) and abundance index (bottom, numbers). Haul in the Spanish Porcupine survey time-series (SpPGFS-WIBTS-Q4, 2001–2019). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000). From Fernández-Zapico *et al.* (WD03 2021a).

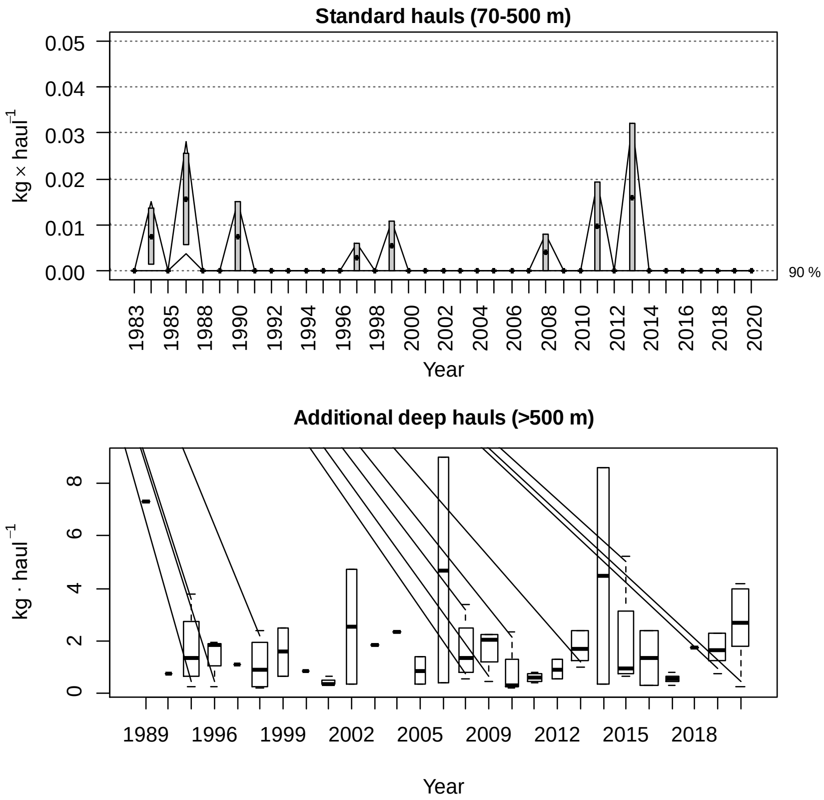

Figure 5.5. Other deep-water sharks and skates from the Northeast Atlantic. Evolution of *Scymnodon ringens* stratified biomass index in standard hauls and in additional deep hauls during the North Spanish shelf bottom trawl survey time series (SpGFS-WIBTS-Q4, 1983–2019). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α = 0.80, bootstrap iterations = 1000). From Fernández-Zapico *et al*. (WD03 2021b).

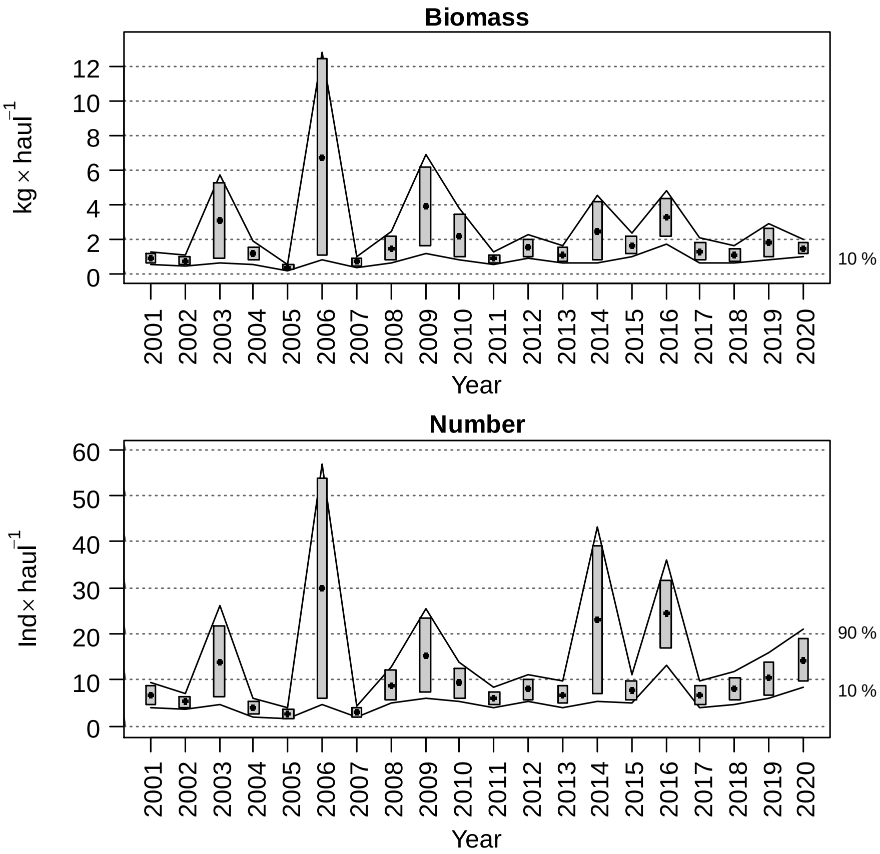

Figure 5.6. Other deep-water sharks and skates from the Northeast Atlantic. *Etmopterus spinax* biomass index (top, kg haul–1) and abundance index (bottom, numbers haul–1) during Porcupine survey time-series (SpPGFS-WIBTS-Q4, 2001–2019). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000). From Fernández-Zapico *et al*. (WD03 2021a).

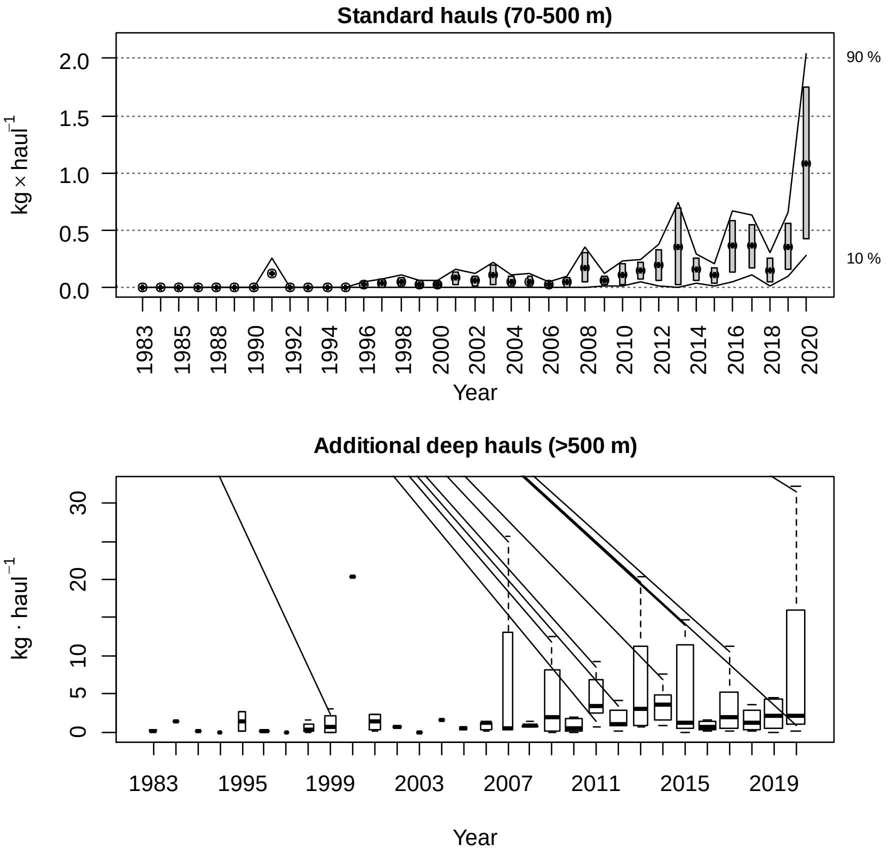

Figure 5.7. Other deep-water sharks and skates from the Northeast Atlantic. Evolution of *Etmopterus spinax* stratified biomass index in standard hauls and in additional deep hauls during the North Spanish shelf bottom trawl survey time series (SpGFS-WIBTS-Q4, 1983–2019) covered by the survey. Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α = 0.80, bootstrap iterations = 1000). From Fernández-Zapico *et al*. (WD03 2021b).

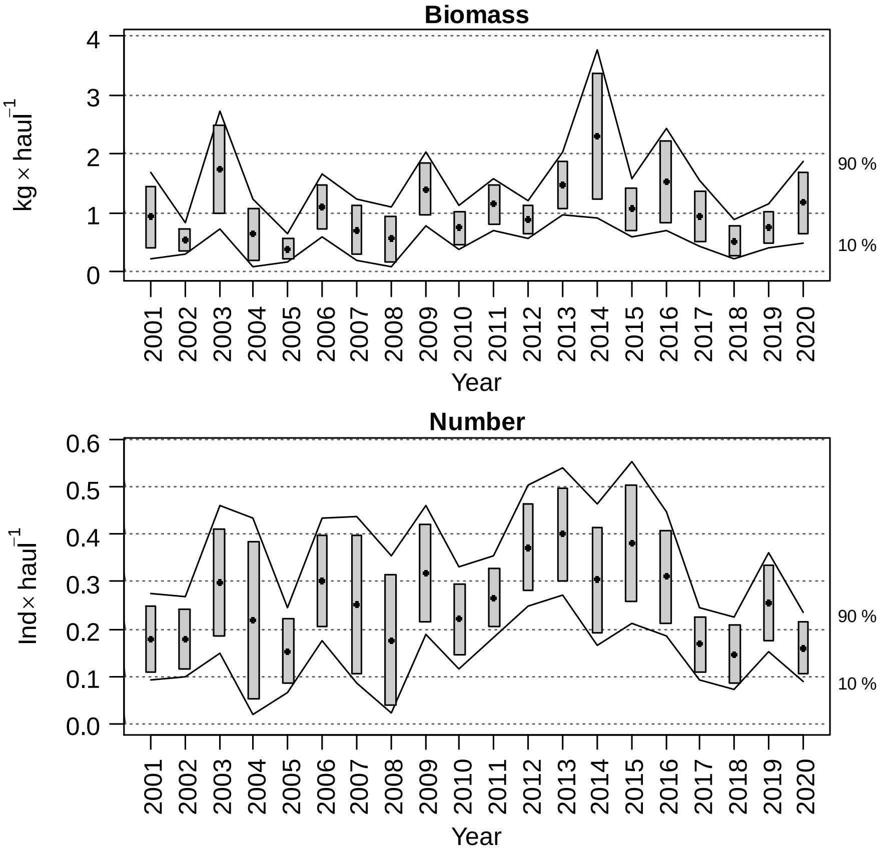

Figure 5.8. Other deep-water sharks and skates from the Northeast Atlantic. Changes in bluntnose six-gill shark *Hexanchus griseus* biomass index (kg haul^{-1}) during Porcupine survey time-series (SpPGFS-WIBTS-Q4, 2001–2019). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000). From Fernández-Zapico *et al.* (WD03 2021a).

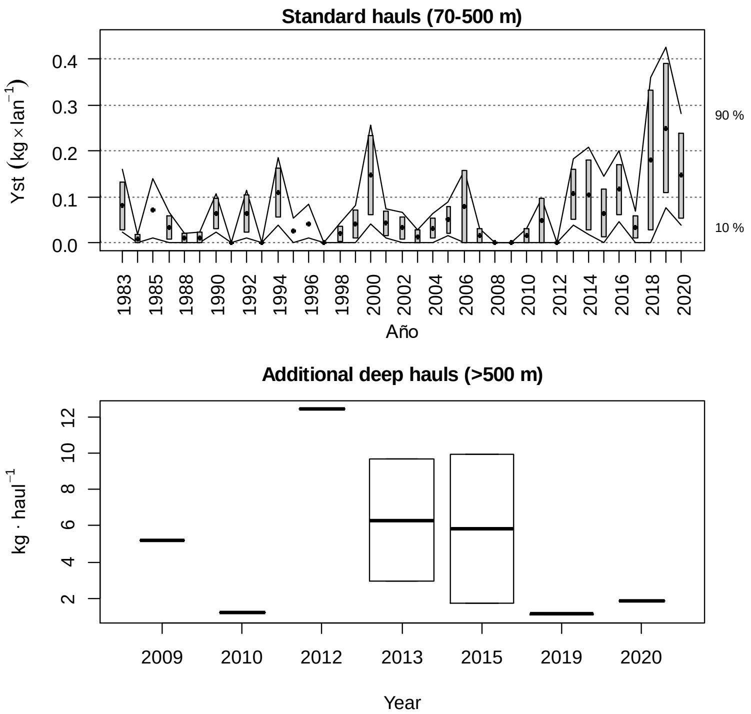

Figure 5.9. Other deep-water sharks and skates from the Northeast Atlantic. Evolution of *Hexanchus griseus* stratified biomass index in standard hauls and in additional deep hauls during the North Spanish shelf bottom trawl survey time series (SpGFS-WIBTS-Q4, 1983–2019). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α = 0.80, bootstrap iterations = 1000). From Fernández-Zapico *et al.* (WD03 2021b).

6 Porbeagle in the Northeast Atlantic (subareas 1–14)

6.1 Stock distribution

WGEF has traditionally considered that there is a single stock of porbeagle *Lamna nasus* in the Northeast Atlantic. The stock occupies the entire ICES area (subareas 1–14) and extends from the Barents Sea to Northwest Africa. For management purposes the southern boundary of the stock is 36°N and the western boundary at 42°W. The information to identify the stock unit is provided in the Stock Annex (ICES, 2011).

Although there is one record of one porbeagle tagged off Ireland and recaptured in American waters (Cameron *et al*., 2018) and genetic studies suggesting that gene flow has occurred across the North Atlantic (Pade, 2009), studies using pop-up satellite archival tags (PSATs) have shown a return migration pattern in the eastern Atlantic without crossing the western boundary of the stock at 42° W (Figure 6.1a and 6.1b). Additionally, of ca. 2000 conventional tags deployed in the NW Atlantic, none of the 209 recaptures (up to 2012) showed a transatlantic migration (Campana *et al*., 2013).

Tag deployments have also provided evidence of site fidelity to spring–summer feeding areas (Biais *et al*., 2017; Cameron *et al*., 2019). This result suggests that porbeagle stock components may have limited connectivity between them. To investigate this possibility, an assessment of the genetic structure of the porbeagle migrating to the Bay of Biscay in spring-summer was carried out in 2020–2021 (Viricel *et al*., 2021 WD02). Preliminary results suggest that stock structure could be more complex than currently assumed.

6.2 The fishery

6.2.1 History of the fishery

The main country catching porbeagle in the last decade was France and, to a lesser extent, Spain, UK and Norway. The only regular target fishery that has existed recently was the French fishery (although there have been seasonal target fisheries in the UK). However, historically there were important Norwegian and Danish target fisheries. Porbeagle is also taken as a bycatch in mixed fisheries, mainly in UK, Ireland, France and Spain. A detailed history of the fishery is in the Stock Annex (ICES, 2011).

Information presented to WGEF 2015 indicated that the Norwegian catch decline in the 1950s and 1960s did not simply reflect a decline in abundance, but also has been influenced by a decrease in effort (Biais *et al*., 2015a WD). The discovery of good fishing grounds off Ireland in 1960 and the failure to find the same abundance on these grounds in the two following years likely played a significant role in the 1960–1963 catch decline (Figure 6.2). Available data on the mean weights of fish indicate that this fishery off Ireland was located on nursery areas (Biais *et al*., 2015b WD). Analyses of long-term landings data need to be interpreted in relation to catch per unit of effort experienced by this fleet in both the Northeast and Northwest Atlantic fishing grounds, as well as other factors (e.g. other fishing opportunities).

6.2.2 The fishery in 2020

No EU fishery has been allowed since the implementation of a zero TAC in 2010. However, some limited landings have been reported since 2010, as well in the previous five years (Table 6.1). The

2021 WGEF estimated landings is 6 t in 2020 and since the zero TAC was implemented in 2010, the mean (2010–2019) WGEF estimate is 25 t per year. However, since 2010 data must be considered as unrepresentative of removals, as dead discards are not quantified.

6.2.3 ICES advice applicable

The 2019 advice is valid for 2020–2023, and stated: "*ICES advises that when the precautionary approach is applied, there should be zero catch in each of the years 2020–2023*"**.**

6.2.4 Management applicable

EC Regulation 1185/2003 prohibits the removal of shark fins and subsequent discarding of the body of this species. This regulation is binding on EC vessels in all waters and non-EC vessels in Community waters.

EC Regulation 40/2008 first established a TAC (581 t) for porbeagle taken in EC and international waters from ICES Subareas 1–12 and 14 for 2008. The TAC was reduced by 25% in 2009 and a maximum landing length of 210 cm (fork length) was implemented.

From 2010–2014, successive EC Regulations (23/2010, 57/2011, 44/2012, 39/2013 and 43/2014) had established a zero TAC for porbeagle in EU waters of the ICES area and prohibited EU vessels to fish for, to retain on board, to tranship and to land porbeagle in international waters.

Since 2015 it has been prohibited for EU vessels to fish for, to retain on board, to tranship or to land porbeagle, with this applying to all waters (Council Regulation (EU) 2015/104, 2016/72, 2017/127, 2018/120, 2019/124, 2020/123 and 2021/92). *Fisheries consultations between the UK and the EU in 2021 have also included porbeagle in the list of prohibited species in Union and UK waters*[1].

It has been forbidden to catch and land porbeagle in Sweden since 2004; and in 2007, Norway banned all direct fisheries for porbeagle but bycatch could be landed up to 2011. Since that year, live specimens must be released, whereas dead specimens can be landed, but this was not mandatory. The species is therefore exempt from the general Norwegian landings obligation, and the payment is therefore withdrawn, except for 20% to cover the cost of landing.

In 2017, a regulation was issued to ban all targeted fishing in Icelandic waters for spurdog, porbeagle and basking shark and stipulating that all viable catch in other fisheries must be released.

6.3 Catch data

6.3.1 Landings

Landings of porbeagle in the Northeast Atlantic from 1926 to 2020 are shown in Table 6.1a and 6.1b and Figure 6.3 and 6.4. From 1971 onwards, France remained the major contributor. The Danish time-series for 1946–1949 was completed at the 2015 WGEF, using the information collected for analysing the trends in the Northern European porbeagle fishery (Biais *et al*., 2015a WD).

More detailed information on landings is presented in the Stock Annex.

[1] Fisheries: consultations between the UK and the EU in 2021 - GOV.UK (www.gov.uk)

6.3.2 Discards

Because of the high value of this species, it is likely that specimens caught incidentally were landed prior to quota becoming restrictive. Historical discards are consequently thought to be low. The EU adoption in 2009 of a maximum landing size for this species likely led to increased discarding of large fishes by vessels from the French directed fishery, although the proportion of large fish was low in the landing of this fishery (< 5%; Hennache and Jung, 2010).

In recent years, the only discard estimate available was provided by France in 2018: 88 t (bottom trawls: 57 t; nets: 26 t; pelagic trawls: 5 t). This estimate suggests that discards can be of the same order of magnitude as the non-directed catches prior to porbeagle being on the fishing ban: 49 t in 2007–2009 for trawls and nets. However, it should be noted that this may be an imprecise estimation as the underlying data relate to few observations and specimens. Anecdotal information suggests that French pelagic trawlers and tuna long liners discard porbeagle, but their total dead discards are unknown.

Current levels of discarding are uncertain, and may seasonally occur in some métiers. For example, observations on porbeagle bycatch have been made for some gillnetters operating in the Celtic Sea (Bendall *et al.*, 2012a, b; Ellis and Bendall, 2015 WD), but there are no estimates of total dead discards.

Data analysis on at-sea observer programme for UK (E&W) fisheries, indicate that porbeagle encountered up to the end of 2009 were typically retained (32% discarded) and that since the introduction of the fishing ban, all observed were discarded (Silva and Ellis, 2019).

Anecdotal information indicates that porbeagle is a regular bycatch in the Norwegian pelagic trawl fishery for blue whiting in the Norwegian Sea. Due to the fishing method, whereby the catch is pumped on board, all specimens are reportedly dead when caught. It was also suggested that there is an increased occurrence of porbeagle in this fishery since 2014/2015. The lack of observer coverage on these vessels means that such observations have not been independently verified.

This species is taken by recreational fishers in some areas, however the full extent of fish captured through this method has not been quantified.

6.3.3 Quality of catch data

Some EU nations have incomplete recording of porbeagle (e.g. they have been reported as generic sharks; have been captured by <10 m LOA vessels). Although catch data for this stock are considered to be underestimated, these are mostly for nations catching small quantities, and more comprehensive data are available for the main fishing nations. Since the zero TAC / prohibited listing was introduced, reported landings are not representative of catch. There are no estimates of recent catches, as only limited data from discard observer trips are available for porbeagle. Furthermore, it is unclear as to whether these data would be sufficiently representative to provide robust estimates of dead removals. The 2005–2015 EU Member States, Norwegian and Icelandic landing have been revised in 2016. Major revisions relate to 2008 and 2009 for French and Spanish landings.

6.3.4 Discard survival

Data on discard survival are limited. Bendall *et al.* (2012a) examined the vitality of porbeagle caught in gillnet fisheries, and only four (20%) of the 20 fish captured were alive. It is important to recognise that this study was based on a small sample size and the soak time was shorter than that adopted by normal fishing operations. Survival on longlines is likely to be much higher, but would depend on soak time. Fishers have reported mortality of porbeagle caught in pelagic trawl fisheries, but this has not been quantified.

6.4 Commercial catch composition

Only limited length data are available. However, length-distributions by sex are available for 2008 and 2009 for the French longline fishery that targeted porbeagle until 2009 (Hennache and Jung, 2010; Figure 6.5). These distributions are considered representative of international catches because during that period France was the major contributor to catch figures.

The composition by weight class (< 50 kg and ≥ 50 kg) of the French fishery catches reveals that the proportion of large porbeagle in the landings was higher before 1998 than after 2003 but with large inter-annual changes (Table 6.2).

Catch data derived from the French longline fishery highlighted the dominance of porbeagle (89%) on the total catch. Other species included blue shark (10%), common thresher (0.6%) and tope (0.3%).

6.4.1 Conversion factors

Length–weight relationships are available for different geographic areas and for time periods (Table 6.3). Relationships between alternative length measurements with total length in porbeagle were presented in 2015 (Table 6.4; Ellis and Bendall, 2015 WD).

6.5 Commercial catch and effort data

A new CPUE series from Norwegian porbeagle longlines (1950–1972) was presented in 2015 (Biais *et al.*, 2015b WD). Personal logbooks of three fishermen (covering periods of three, 10 and 15 years) were used to get this new series. Data were reported for each fishing day of the trip, including days with zero catch. Most of the fishing days were in northern European waters (divisions 2.a, 4.a-b, 5.a and 6.a (north of 59°N)), the historical Norwegian fishing zone, but some data were also available for fishing days west of the British Isles, including the Celtic Sea.

The time-series trend in this area was explored by carrying out a GLM on log transformed values fitted with a gamma link function. The annual index series provided by this analysis showed no significant temporal trend (Figure 6.6). The CPUE series was revised in 2021 to assign fishing days to rectangles of one degree in latitude and one degree in longitude. This enabled the definition of six areas better in line with the distribution of high daily catches, compared to when allocating to ICES subdivisions. An annual index series was obtained by carrying out a GLM on log transformed values fitted with a gamma link function, using the new areas. This revision continues to show no significant trend (Biais, 2021 WD07).

A CPUE series based on data collected from 17 boats belonging to the French longline fishery was presented by Biais and Vollette (2009). These boats landed more than 500 kg of porbeagle per year during more than six years after 1972 and more than four years from 1999 onwards. The latter allowed inclusion of a vessel that had entered the fishery towards the end of the time-series, given the limited number of boats in recent years.

At the 2009 ICCAT-ICES meeting, standardized catch rates were also presented for North Atlantic porbeagle during the period 1986–2007, caught as low prevalent bycatch in the Spanish surface longline fishery targeting swordfish in the Atlantic Ocean (Mejuto *et al.*, 2009). The analysis was performed using a GLM approach that considered several factors such as longline type, quarter, bait and also spatial effects by including seven zones.

The nominal and the standardized catch rate series of the French fleet show that higher values occurred by the late 1970s (Figure 6.7). Since then, CPUE has varied between 400–900 kg per day without showing a trend.

The caution with which trends over short periods must be considered was shown by an analysis of the effect of porbeagle aggregating behaviour, as well as an effect of cooperation between skippers. The analysis was carried out for years 2001–2008 for which detailed data were available (Biais and Vollette, 2010). The analysis showed that inter-annual variation in local abundance may be higher than indicated by catch by trip or catch by day.

Spanish data showed a higher variability than the French (Figure 6.8), possibly as they were based on bycatch data and derived from fishing fleet that operate in areas with lower abundance of porbeagle.

6.6 Fishery-independent surveys

An abundance survey was carried out in May–June 2018 and 2019 by France (Ifremer) on board a chartered longliner (Biais, 2019 WD). The longline was the same as that formerly used by commercial vessels, but shorter on average (336 hooks per set; 1 or 2 sets per day). A sampling protocol with fixed stations was adopted, as in the Western Atlantic (Campana *et al*, 2013). The survey area stretches from latitudes 45° to 48° N along the shelf edge (depths from 700 to 4000 m) westwards of France. The survey grid includes 32 stations: two by statistical rectangle of the survey area. One to three longline sets were carried out on each of them with the condition to have at least 10 days between two sets. The abundance index (average CPUE) are consistent between them: 3.6 fish/336 hooks in 2018 and 3.0 fish/336 hooks in 2019.

A comparison of these results with a commercial CPUE series was made possible by the availability of a skipper's diaries (Biais, 2019 WD). Detailed information of these diaries allowed several selections of longline sets to get a CPUE series comparable to the survey index:

- If the vessel stays in the same statistical rectangle more than one day, the sets of the following days are not selected before 10 days;
- If two sets are made in the same statistical rectangle the same day, the second set is selected only if the distance between the two sets is larger than the distance between the two stations of the survey in this statistical rectangle;
- If the vessel moves to another statistical rectangle, the set is selected only if its distance from the preceding set is larger than the distance between the two stations of the survey in this statistical rectangle.

Survey indices are close to the mean CPUE of this commercial time series (Figure 6.9). This result and inter-annual consistency of survey indices allow thinking that the design of the survey is relevant to provide abundance indices. Furthermore, the comparison with the commercial CPUE series suggests that the porbeagle mean abundance on the shelf edge westwards of France of 2018–19 is at similar levels than the mean abundance of 2005–2009, if we are considering the recent survey area with previous commercial data. However, it should be noted that the commercial CPUE may be biased upwards because commercial sets are not deployed all over the survey area but in ICES statistical rectangles where the skipper expected the best CPUE (6–12 out of 16, depending of the year).

To show the effect of the possible bias caused by the lack of commercial CPUE for part of the survey area, the survey index was calculated using only data from the 10 statistical rectangles where the CPUE are the largest each year (corresponding to the removal of statistical rectangles with an average CPUE < 1 in 2018 and <= 1.5 in 2019). The reason to look at these data in such a way, relates to the fact that fishermen in order to make fishing activity commercially viable, would likely not operate in areas with low CPUE, moreover when these ICES statistical rectangles are close to each other. The average survey index for the period 2018–2019 is thus 4.5, which is 30% higher than the average of the commercial CPUE for the period 2005–2009.

Because the increase in modes of the porbeagle length distribution from 2008–2009 to 2018–2019 (Figure 6.10), an increase in biomass from 2009 to 2019 is even more likely.

6.7 Life-history information

Life-history information (including habitat description) is presented in Stock Annex.

Nicolaus *et al.* (2015 WD) reported high levels of mercury (Hg) in both the red and white muscle of porbeagle (n = 33) caught in the Celtic Sea. Hg concentrations in either the red or white muscle that exceeded the maximum levels established in European regulations for seafood were observed in a third of specimens. Hg concentration, however, increased with length, and all fish > 195 cm total length had concentrations > 1.0 mg kg^{-1}, with a maximum observed value of 2.0 mg kg^{-1}.

6.7.1 Movements and migrations

Migrations of three porbeagle tagged off Ireland with archival pop-up tags (PAT) in 2008 and 2009 are described by Saunders *et al.* (2011). One specimen migrated 2400 km to the northwest off Morocco, residing around the Bay of Biscay for about 30 days. The other two remained in off-shelf regions around the Celtic Sea/Bay of Biscay and off western Ireland. They occupied a vertical distribution ranging from 0–700 m and at temperatures of 9–17°C, but during the night they preferentially stayed at upper layers.

The UK (CEFAS) launched a tagging program in 2010 to address the issue of porbeagle bycatch and to further promote the understanding of porbeagle movement patterns in UK marine waters. Altogether, 21 satellite tags were deployed between July 2010 and September 2011, and 15 tags popped off after two to six months. However, four tags failed to communicate. The tags attached to sharks in the Celtic Sea generally popped off to the south of the release positions while those to sharks off the northwest coast of Ireland popped off in diverse positions. One tag popped off in the western part of the North Atlantic, one close to the Gibraltar Straits and another in the North Sea. Several tags popped off close to the point of release (Bendall *et al*., 2012b).

In June–July 2011, France (IFREMER and IRD) joined the international tagging effort in cooperation with CEFAS by undertaking a survey on the shelf edge in the West of Brittany. A second survey was carried out in 2013 by Ifremer. Three PATs were deployed by IFREMER-IRD and three by CEFAS (results in Bendall *et al*., 2012a) during the 2011 survey, and nine during the 2013 survey. Pop-off dates were set at twelve months for the PSATs deployed by France which were all used to tag large females (L_T > 2 m). Eight PSATs popped up after four months and four at twelve months. Track reconstructions, based on Grid Filtering, were carried out for these eight tags (Biais *et al*., 2017). They revealed large migrations of the sharks; going from the Bay of Biscay northward to the Arctic Circle, southward to Madeira and three fish moved westwards to the Mid-Atlantic Ridge. A general circular migration pattern was observed with a return to the Bay of Biscay or the SW Celtic Sea shelf edge when PSATS popped up at 12 months. In these cases, the small observed distances between tagging and pop-up positions (mean 190 km) are remarkable given that movements could be of several thousand km.

An exploratory abundance survey for porbeagle in the Bay of Biscay was undertaken by France in summer 2016, including the deployment of 7 PATs. One PAT never transmitted, three premature pop-ups (< 1 month) were observed and one PAT transmitted in February just off the northwest coast of Spain. The two remaining PATs popped up on schedule at 12 months. The corresponding estimated tracks show again that porbeagle has an annual circular migration pattern. These PAT deployments were completed in 2018 by the tagging of 31 porbeagle during the 2018 French abundance survey. Twenty-nine of these 31 PATs popped up at more than 4 months and 12 at one year (average time at liberty is 280 days). Seven additional PATs have been deployed during the 2019 French abundance survey.

A recent study used landings data from 2005–2019 to investigate the spatial distribution of porbeagle along the Norwegian coast, with one hotspot area identified in summer around Trondheim (Central Norway) (MSc thesis, Triginer 2020).

6.7.2 Reproductive biology

A research programme carried out by the NGO APECS (Hennache and Jung, 2010) provided information based on a large sampling (n = 1770) on the French catch in 2008–2009. Spatial sex-ratio segregations are documented and information is provided on the likelihood of a nursery ground in St. George's Channel and of a pupping area in the grounds along the western Celtic Sea shelf edge. Further evidence of parturition close to the western European shelf was provided by the captures of 9 new born pups on the Bay of Biscay shelf break in May 2015 and July 2016 (Biais *et al*., 2017) as well as by the captures of pregnant females during the 2018 abundance survey.

Two catches of gravid females containing large embryos (60–63 and 66–76 cm T_L) were also reported in East-Scotland and around Shetland in May and June, indicating that parturition is in the summer or autumn (Gauld, 1989). They suggest that another pupping ground may be situated in this area with a later parturition than in southern waters.

6.7.3 Genetic information

A first study of the genetic diversity (mitochondrial DNA haplotype and nucleotide diversities) was carried by Pade (2009). This study was based on 156 individuals caught both on the Northeast and Northwest Atlantic; the results obtained show no significant population structure across the North Atlantic. These findings were supported by another study which examined 224 specimens from eight sites across the North Atlantic and the Southern Hemisphere (Testerman, 2014). However, this study showed strong genetic difference between the North Atlantic and Southern Hemisphere, which indicates two genetically distinct populations

Pade (2009) found also that while the mtDNA haplotype diversity was very high, sequence diversity was low, which suggests that most females breed in particular places, which also indicates the stock is likely to be genetically robust (Pade, 2009).

In an on-going genetic study, Viricel *et al*. (2021 WD02) observed also high levels of genetic diversity at the mitochondrial DNA control region in North Atlantic, using 49 individuals caught in the Bay of Biscay from 2013 to 2019, 6 individuals from the Indian ocean and 155 sequences obtained from Genbank from both North and South Atlantic. Preliminary results show significant differences between haplotype frequencies of two groups of individuals tagged in the Bay of Biscay, according to migrations towards the West or towards the North in Autumn-Winter. However, it should be noted that these results were obtained using a single locus and a low sample size for the two migratory groups (N = 9–10 individuals) and thus, viewed with caution. Therefore, the hypothesis that porbeagle stock in the NE Atlantic may include distinct populations will be further investigated using nuclear markers in 2021.

Further studies examining genetic structure of Mediterranean Sea porbeagle are still required.

6.8 Exploratory assessment models

6.8.1 Previous studies

The first assessment of the Northeast Atlantic stock was carried out in 2009 by the joint ICCAT/ICES meeting (ICCAT, 2009; ICES, 2009) using a Bayesian Surplus Production (BSP) model (Babcock and Cortes, 2009) and an age-structured production (ASP) model (Porch *et al.*, 2006). The 2009 assessments have not been updated since.

Using the French CPUE series as well as the Spanish CPUE series, stock projections based on the BSP model demonstrated that low catches (below 200 t) may allow the stock to increase under most credible model scenarios and that the recovery to B_{MSY} could be achieved within 25–50 years under nearly all model scenarios. However, it is important to recognise both the uncertainty in the input parameters for this assessment and the low productivity of the stock. More detailed results from these are detailed in the Stock Annex.

6.8.2 The SPiCT model

In 2018, a working document (Albert, 2018) has presented different exploratory runs of the SPiCT model (Pedersen and Berg, 2016). They were based on the French CPUE index available for the years 1972–2007 (Figure 6.7) and landings data from 1950–2016 (presented in the 2017 WGEF report; ICES, 2017).

The best results were from runs that used the full set of landing data (1950–2016). They indicate that the stock biomass is either above or not too far below B_{MSY} in final year. With the present F far below F_{MSY}, a commercial porbeagle fishery may therefore again become advisable in the near or medium-term future. However, these exploratory runs need to be further scrutinized before the results can be considered as indicative of the present status of the stock. Details are in the 2018 WGEF report (ICES, 2018).

In 2021, other SPiCT runs were presented (Biais, 2021 WD07). The consistency between the SPiCT and BSP assessments was examined with a SPiCT run carried out with the same data and parameters as the run referenced NE1 of the previous BSP assessment (ICCAT, 2009). Both models agree on the order of magnitude of K and Bmsy, but B/Bmsy in terminal year is higher for the BSP model. Additional SPiCT runs were carried out with the Norwegian CPUE series. For this first exploratory assessment using CPUEs spanning to the period of high catches after WWII, the runs were stopped in 1970 to assess trends in biomass and mortalities with catches and CPUE from the same fishery. The B/Bmsy estimates are uncertain, possibly because the CPUE trend is flat. However, further analysis of this CPUE series is needed as recent analysis of the Norwegian logbooks in 2021 provided with a better precision of CPUE locations.

6.9 Stock assessment

Since the closure of the fishery and the designation of porbeagle as a prohibited species, there are insufficient commercial data (and fishery-independent data) with which to ascertain the current status of the stock.

In order to close data gaps and identify important areas for life-history stages (e.g. mating, pupping and nursery grounds), ICCAT has encouraged research and monitoring projects at stock level to start in 2017 (ICCAT, 2016).

6.10 Quality of assessments

The assessments (and subsequent projections) conducted at the joint ICCAT/ICES meeting that are summarized in the Stock Annex were considered exploratory assessments, considering the assumptions (carrying capacity for the SSB model, F in the historic period in the ASP model) and available data, (particularly a lack of CPUE data for the peak of the fishery; uncertainty in some of the landings data). Consequently, the model outputs were considered highly uncertain (ICCAT, 2009) and in 2009 and subsequent years, WGEF considered that there was insufficient new information to inform on current stock status.

Available CPUE from Norwegian vessels showed no trend from 1950 to 1972. This information, provided at the 2015 WGEF, also suggests that the northern fisheries ceased partly because of the attraction of other fisheries. It underlines also that economic and social factors are important considerations in explaining why a fishery may not operate or resume even if the abundance does not decline. An update of the ICES/ICCAT assessment should consider these new data as well as recent fishery-independent data.

6.11 Reference points

ICCAT uses F/F_{MSY} and B/B_{MSY} as reference points for stock status of pelagic shark stocks. These reference points are relative metrics rather than absolute values. The absolute values of B_{MSY} and F_{MSY} depend on model assumptions and results and are not presented by ICCAT for advisory purposes.

6.12 Conservation considerations

At present, the porbeagle shark subpopulation of the Northeast Atlantic is listed as Critically Endangered in the IUCN red list (Ellis *et al*., 2015).

In 2013, a renewed proposal to list porbeagle shark on Appendix II of CITES was accepted at the Conference of Parties (16) Bangkok, and it has been listed since September 2014.

6.13 Management considerations

WGEF/ICCAT considered all available data in 2009. This included updated landings data and CPUE from the French and Spanish fisheries. Collation of historical information, as provided in 2015, supports the need to update the ICCAT/ICES assessment.

The new CPUE series provided for the Norwegian fishery from 1950 to 1972 further highlights the difficulties in interpreting stock trends with contrasting trends in CPUE and landings.

In the absence of target fisheries and reliable information on bycatch and discards, one or several dedicated longline surveys covering the main parts of the stock area would be needed if stock status is to be monitored appropriately. The surveys carried out by France in 2018 and 2019 have shown that a fixed stations survey design can provide consistent annual indices. A 2000–2009 commercial series drawn up with selections to make it comparable to the survey indices (elimination of repeated sets of longlines) provides further evidence of consistency of the survey results. The comparison of 2018–19 survey indices with this 2000–2009 CPUE series and the increase in modal length of catches from 2009 to 2019 suggest that the biomass of the population that come back to the Bay of Biscay and the Celtic Sea in spring-summer has increased in recent years.

Continuing this spring-summer survey with an expansion to other areas within the stock distribution would be advantageous, as this would provide the necessary sampling effort to take the large distribution of porbeagle into account in order to monitor stock size.

This species has low population productivity, and is thus highly susceptible to overexploitation. Consequently, WGEF considers that target fishing should not proceed without a programme to monitor stock abundance. Current fishing ban may prove difficult to obtain a more robust estimate of discards, which are considered to have increased in recent years in the Bay of Biscay as well as in northern part of the distribution area of the stock. WGEF also highlight that the present fishing ban hampers any quantitative assessment of current stock status.

A maximum landing length (MLL) was adopted by the EC in 2009. It constituted a potentially useful management measure in targeted fisheries, as it should deter targeting areas with mature females. However, there are also potential benefits from limiting fishing mortality on juveniles. Given the difficulties in measuring (live) sharks, other body dimensions (e.g. height of the first dorsal fin or pre-oral length) that could be pragmatic surrogate measurements could usefully be identified. The correlation of some measurements with fork length is high (Bendall *et al.*, 2012a) but further studies, so as to better account for natural variation (e.g. potential ontogenetic variation and sexual dimorphism) in such measurements, are needed to identify the most appropriate options for managing size restrictions.

Further ecological studies on porbeagle, as highlighted in the scientific recommendations of ICCAT (2009), would help to further develop management measures for this species. Such work could usefully build on recent and on-going tagging projects, and various Member States have undertaken increasing studies on porbeagle.

Studies on porbeagle bycatch should be continued to develop operational ways to reduce bycatch, to decrease at-vessel mortality and to improve the post-release survivorship of discarded porbeagle.

All fisheries-dependent data should be provided by the Member States having fisheries for this stock, as well as other countries longlining in the ICES area.

6.14 References

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Table 6.1a. Porbeagle in the Northeast Atlantic. Working Group estimates of porbeagle landings data (tonnes) by country (1926–1970). Data derived from ICCAT, ICES and national data. Data are considered an underestimate.

Year	Estimated Spanish data	Denmark	Norway (NEA)	Scotland	Total
1926			279		279
1927			457		457
1928			611		611
1929			832		832
1930			1505		1505
1931			1106		1106
1932			1603		1603
1933			3884		3884
1934			3626		3626
1935			1993		1993
1936			2459		2459
1937			2805		2805
1938			2733		2733
1939			2213		2213
1940			104		104
1941			283		283
1942			288		288
1943			351		351
1944			321		321
1945			927		927
1946		1400	1088		2488
1947		3300	2824		6124
1948		2100	1914		4014
1949		1700	1251		2951
1950	4	1900	1358		3262
1951	3	1600	778		2381
1952	3	1600	606		2209
1953	4	1100	712		1816
1954	1	651	594		1246
1955	2	578	897		1477
1956	1	446	871		1318
1957	3	561	1097		1661
1958	3	653	1080	7	1743
1959	3	562	1183	9	1757
1960	2	362	1929	10	2303
1961	5	425	1053	9	1492
1962	7	304	444	20	775
1963	3	173	121	17	314
1964	6	216	89	5	316

Year	Estimated Spanish data	Denmark	Norway (NEA)	Scotland	Total
1965	4	165	204	8	381
1966	9	131	218	6	364
1967	8	144	305	7	464
1968	11	111	677	7	806
1969	11	100	909	3	1023
1970	10	124	269	5	408

Table 6.1b. Porbeagle in the Northeast Atlantic. Working Group estimates of porbeagle landings data (tonnes) by country (1971–2020). Data are considered an underestimate for some (minor) fishing countries. Data are derived from ICCAT, ICES and FAO data, National reports and data bases and 2015–2021 Data calls. Note: '.' = zero catch ; '+' = < 0.5 t; NA – data not available. Faroe Is. data from 2015–2020 have been revised in 2021 (source: https://statbank.hagstova.fo).

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Denmark	311	523	158	170	265	233	289	112	72	176	158	84	45	38	72
Faroe Is	1	.	5	.	.	1	5	9	25	8	6	17	12	14	12
France	550	910	545	380	455	655	450	550	650	640	500	480	490	300	196
Germany			6	3	4	.	.	.	.	.	.	.	.	.	.
Iceland			2	2	4	3	3	.	1	1	1	1	1	1	1
Ireland			.	.	.	.	.	.	.	.	.	.	.	.	.
Netherlands			.	.	.	.	.	.	.	.	.	.	.	.	.
Norway	111	293	230	165	304	259	77	76	106	84	93	33	33	97	80
Portugal			.	.	.	.	.	.	.	.	.	.	.	.	.
Spain	11	10	12	9	12	9	10	11	8	12	12	14	28	20	23
Spain (Basque Country)															
Sweden			.	.	3		.	5	1	8	5	6	5	9	10
UK (E,W, NI)		4	14	15	16	25	.	.	1	3	2	1	2	5	12
UK (Scot)	7	15	13	.	.	.	.	.	.	.	.	.	.	.	.
Japan	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TOTAL	991	1755	985	744	1063	1185	834	763	864	932	777	636	616	484	406

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Denmark	114	56	33	33	46	85	80	91	93	86	72	69	85	107	73
Faroe Is	12	33	14	14	14	7	20	76	48	44	8	9	7	10	13
France	208	233	341	327	546	306	466	642	824	644	450	495	435	273	361
Germany	.	.	.	.	.	.	.	1	.	.	.	.	2	+	17
Iceland	1	1	1	1	.	.	1	3	4	5	3	2	3	3	2
Ireland	.	.	.	.	.	.	.	.	.	.	.	.	.	8	2
Netherlands	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
Norway	24	25	12	27	45	35	43	24	26	28	31	19	28	34	23
Portugal	.	3	3	2	2	1	+	1	1	1	1	1	1	+	15
Spain	26	30	61	40	26	46	15	21	49	17	39	23	22	15	11
Spain (Basque Country)											20	12	27	41	38
Sweden	8	5	3	3	2	2	4	3	2	2	1	1	1	1	1
UK (E,W, NI)	6	3	3	15	9	.	.	.	.	+	.	.	1	6	7
UK (Scot)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Japan	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	3	2	NA	NA	NA
TOTAL	399	389	471	462	690	482	629	862	1047	827	628	633	612	498	563

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Denmark	76	42	21	20	3	3	2	2	4	.	2	3	.	.	.
Faroe Is	8	10	14	5	18	21	14	10	13	14	18	25	17	15	7
France	339	439	394	374	295	226	371	330	337	10	2	27	13	2	3
Germany	1	3	5	6	5	+	2	2	+	.	+	+	.	.	.
Iceland	4	2	+	1	+		+	1	1	1	1	1	1	+	+
Ireland	6	3	3	+	3	4	8	7	3	+	.	.	.	.	.
Netherlands	.	.	+	.	+	.	+	+	.	+	.	.	.	.	+
Norway	17	14	19	24	12	27	10	12	10	12	11	17	9	5	4
Portugal	4	11	4	57	+	+	+	+	.	+	+	.	.	+	.
Spain	68	65	44	19	18	87	52	269	150	+	+	+	.	.	.
Sweden	1	.	.	5	+	.	+	+	+	.	.	.	.	.	.
UK	10	7	25	24	24	12	26	15	11	+	+	+	.	.	.
Japan	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TOTAL	534	596	529	535	378	380	485	648	529	37	34	73	40	22	14

	2016	2017	2018	2019	2020
Denmark	+	+	.	+	+
Faroe Is	3	1	1	1	1
France	+	1	1	2	+
Germany	.	.	.	.	.
Iceland	2	1	1	3	3
Ireland	.	.	.	.	.
Netherlands	.	.	.	+	.
Norway	6	6	3	4	3
Portugal	.	.	.	.	.
Spain	.	.	2	.	.
Sweden	.	.	.	.	.
UK	.	.	.	.	.
Japan	NA	NA	NA	NA	NA
TOTAL	11	9	8	10	6

Table 6.2. Porbeagle in the Northeast Atlantic. Proportion of small (< 50 kg) and large (≥ 50 kg) porbeagle taken in the French longline fishery 1992–2009. Source: Hennache and Jung (2010).

Year	% Weight of in the catches of porbeagle:	
	< 50 kg	> 50 kg
1992	26.0	74.0
1993	29.7	70.3
1994	33.1	66.9
1995	49.9	53.1
1996	31.9	68.1
1997	39.2	60.8
1998	Data not available by weight category	
1999		
2000		
2001		
2002		
2003	53.7	46.3
2004	44.0	56.0
2005	40.0	60.0
2006	44.3	55.7
2007	44.9	55.1
2008	45.9	54.1
2009	51.8	48.2

Table 6.3. Porbeagle in the Northeast Atlantic. Length–weight relationships of porbeagle from scientific studies.

Stock	L-W relationship	Sex	n	Length range	Source
NW Atlantic	$W = (1.4823 \times 10^{-5})\ L_F\ 2.9641$	C	15	106–227 cm	Kohler *et al.*, 1995
NE Atlantic (Bristol Channel)	$W = (1.292 \times 10^{-4})\ L_T\ 2.4644$	C	71	114–187 cm	Ellis and Shackley, 1995
NE Atlantic (N/NW Spain)	$W = (2.77 \times 10^{-4})\ L_F\ 2.3958$	M	39		Mejuto and Garcés, 1984
	$W = (3.90 \times 10^{-6})\ L_F\ 3.2070$	F	26		
NE Atlantic (SW England)	$W = (1.07 \times 10^{-5})\ L_T\ 2.99$	C	17		Stevens, 1990
NE Atlantic (Biscay / SW England/ W Ireland)	$W = (4 \times 10^{-5})\ L_F\ 2.7316$	M	564	88–230 cm	Hennache and Jung, 2010
	$W = (3 \times 10^{-5})\ L_F\ 2.8226$	F	456	93–249 cm	
	$W = (4 \times 10^{-5})\ L_F\ 2.7767$	C	1020	88–249 cm	

Table 6.4. Porbeagle in the Northeast Atlantic. Relationships between alternative length measurements with total length in porbeagle (n = 53), where total length refers to the total length with the upper lobe of the caudal fin flexed down (L_{T_under}) and measured under the body. Relationships given as an equation and in proportional terms (percentage of L_{T_under}). Source: Ellis and Bendall (2015 WD).

Measurement	Equation	r^2
Total length (depressed), measured over body (L_{T_over})	$L_{T\_over} = 1.0279.L_{T\_under} – 0.3109$	0.99
Total length (natural), measured under body (L_{N_under})	$L_{N\_under} = 0.9906.L_{T\_under} – 3.9749$	0.99
Total length (natural), measured over body (L_{N_over})	$L_{N\_over} = 0.9979.L_{T\_under} – 1.0713$	0.99
Fork length, measured under body (L_{F_under})	$L_{F\_under} = 0.877.L_{T\_under} – 3.6981$	0.99
Fork length, measured over body (L_{F_over})	$L_{F\_over} = 0.8919.L_{T\_under} – 1.4538$	0.99
Standard length, measured under body (L_{S_under})	$L_{S\_under} = 0.7688.L_{T\_under} – 2.1165$	0.99
Standard length, measured over body (L_{S_over})	$L_{S\_over} = 0.7849.L_{T\_under} – 0.2599$	0.99

Measurement	% of L_{T_under} (mean ± SD and range)
Total length (depressed), measured over body (L_{T_over})	102.6 ± 1.31 (100.0–106.7)
Total length (natural), measured under body (L_{N_under})	96.7 ± 1.72 (91.9–101.9)
Total length (natural), measured over body (L_{N_over})	99.1 ± 1.82 (95.3–102.6)
Fork length, measured under body (L_{F_under})	85.5 ± 0.99 (83.3–88.9)
Fork length, measured over body (L_{F_over})	88.3 ± 1.34 (85.2–92.5)
Standard length, measured under body (L_{S_under})	75.6 ± 1.07 (74.1–79.1)
Standard length, measured over body (L_{S_over})	78.3 ± 1.34 (75.6–82.2)

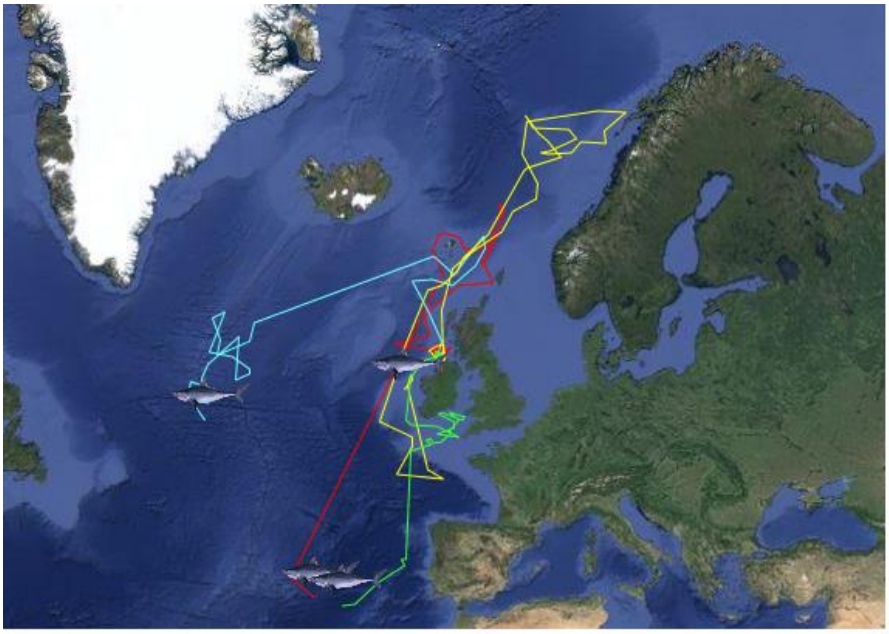

Figure 6.1a. Porbeagle in the Northeast Atlantic. Movement of porbeagle tagged in Irish porbeagle archival tagging programme.

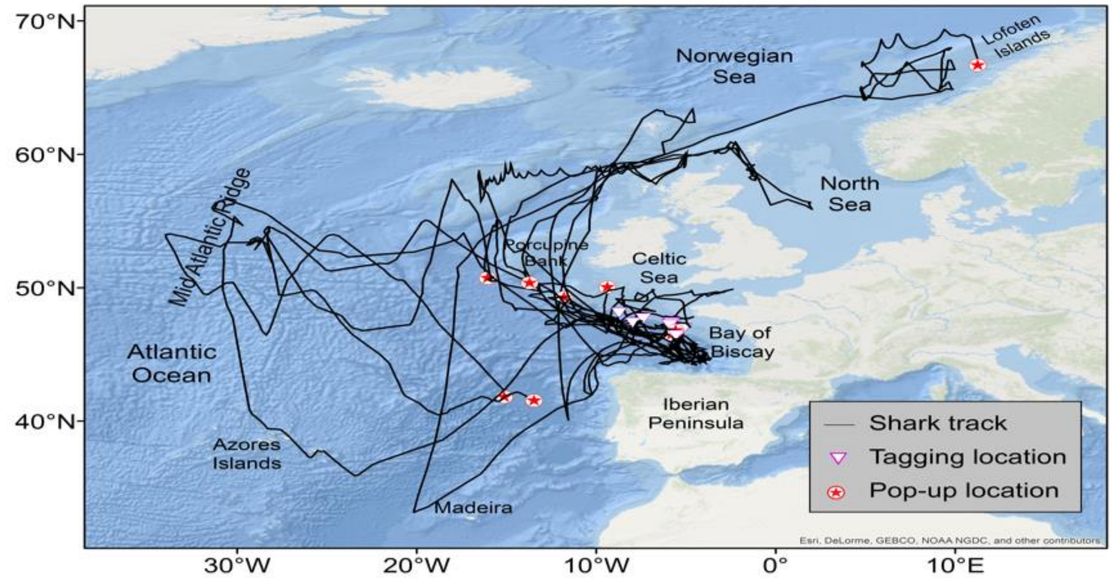

Figure 6.1b. Porbeagle in the Northeast Atlantic. Movement of porbeagle tagged in French porbeagle archival tagging programme (Biais *et al.*, 2017).

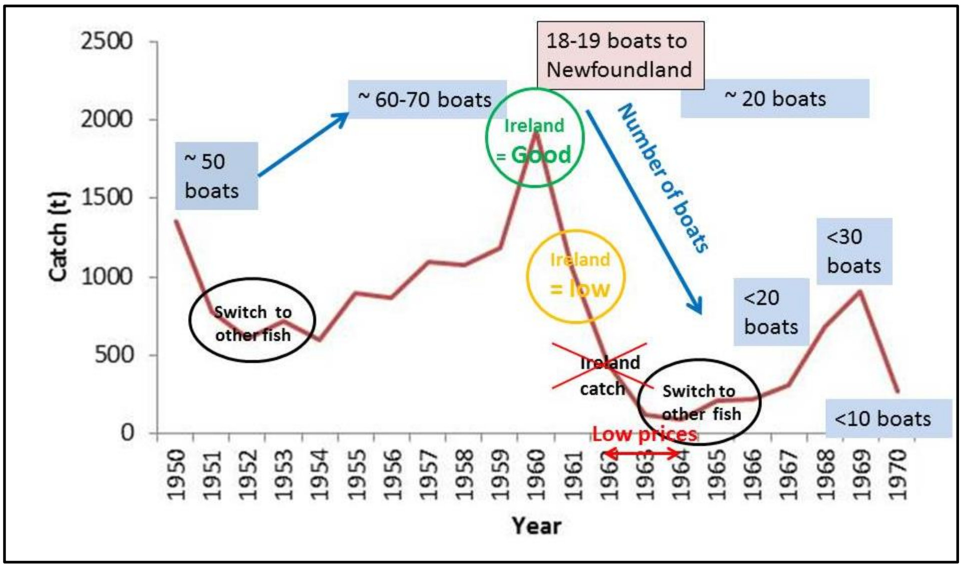

Figure 6.2 Porbeagle in the Northeast Atlantic. Trend in Norwegian catch and information on the fishery (1950–1970). Source: Biais *et al.* (2015a WD).

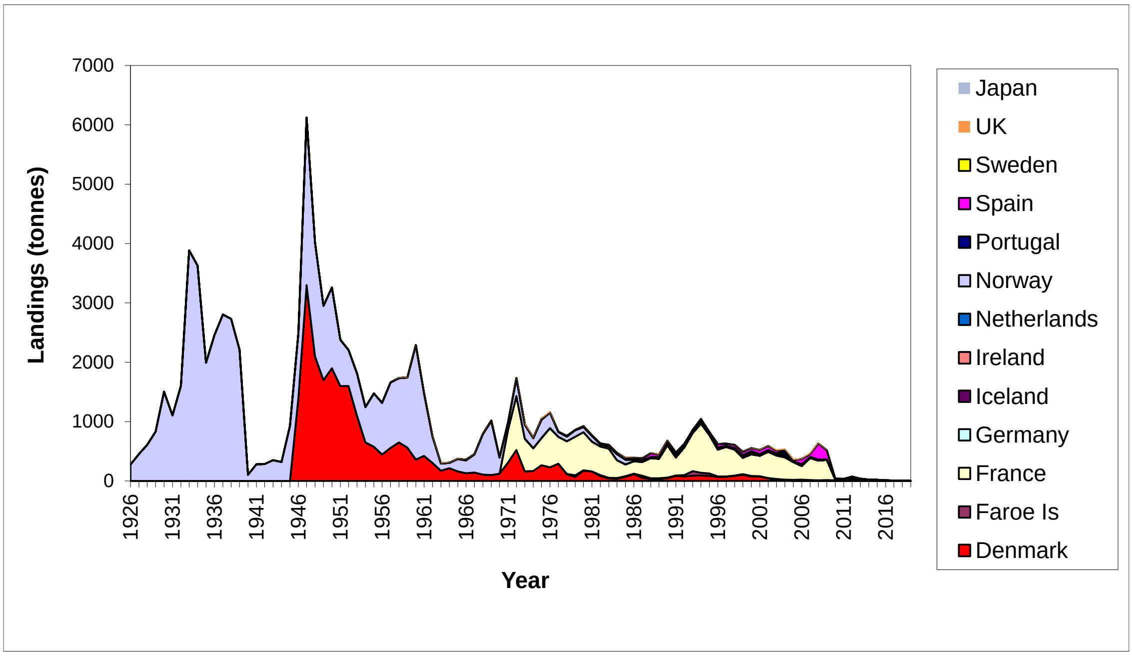

Figure 6.3. Porbeagle in the Northeast Atlantic. Working Group estimates of longer term trend in landings of porbeagle in the Northeast Atlantic (1926–2019).

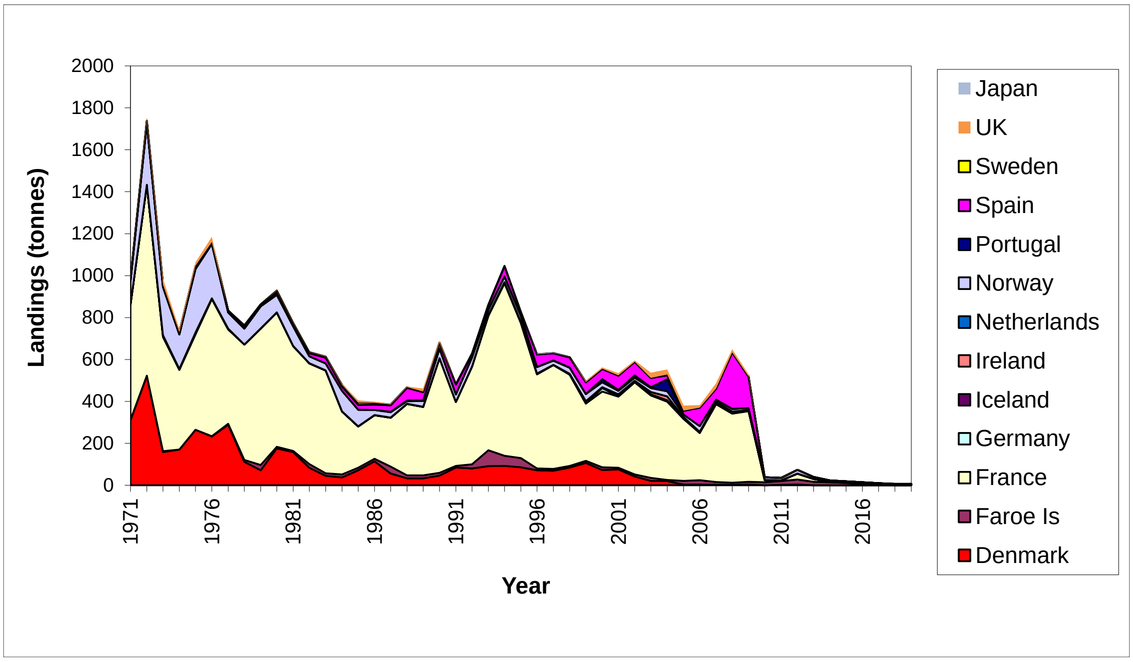

Figure 6.4. Porbeagle in the Northeast Atlantic. Working Group estimates of landings of porbeagle in the Northeast Atlantic for 1971–2019 by country.

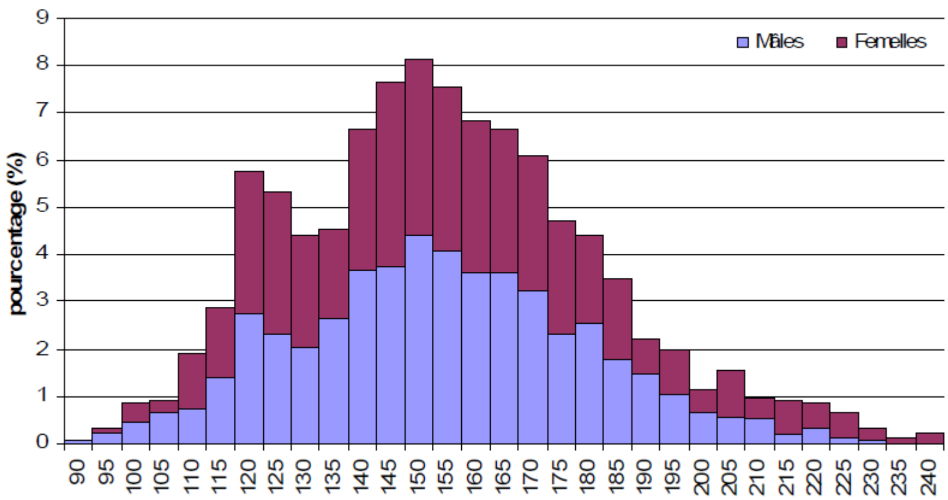

Figure 6.5. Porbeagle in the Northeast Atlantic. Length–frequency distribution of the landings of the Ile d'Yeu target fishery for porbeagle (2008–2009; n = 1769). Source: Hennache and Jung (2010).

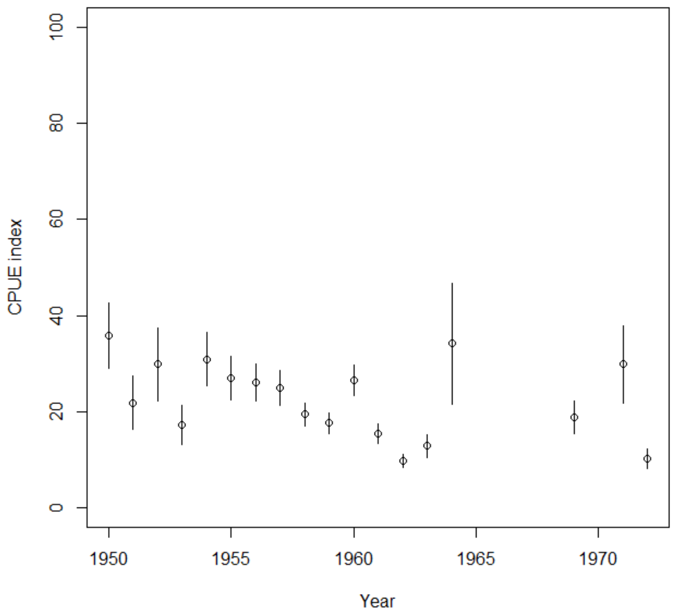

Figure 6.6. Porbeagle in the Northeast Atlantic. Temporal trends in a CPUE index for the Norwegian target longline fishery for porbeagle (1950–1972) in the northern European waters (divisions 2.a, 4.a-b, 5.a and 6.a (North of 59°N)). Source: Biais *et al.* (2015b WD).

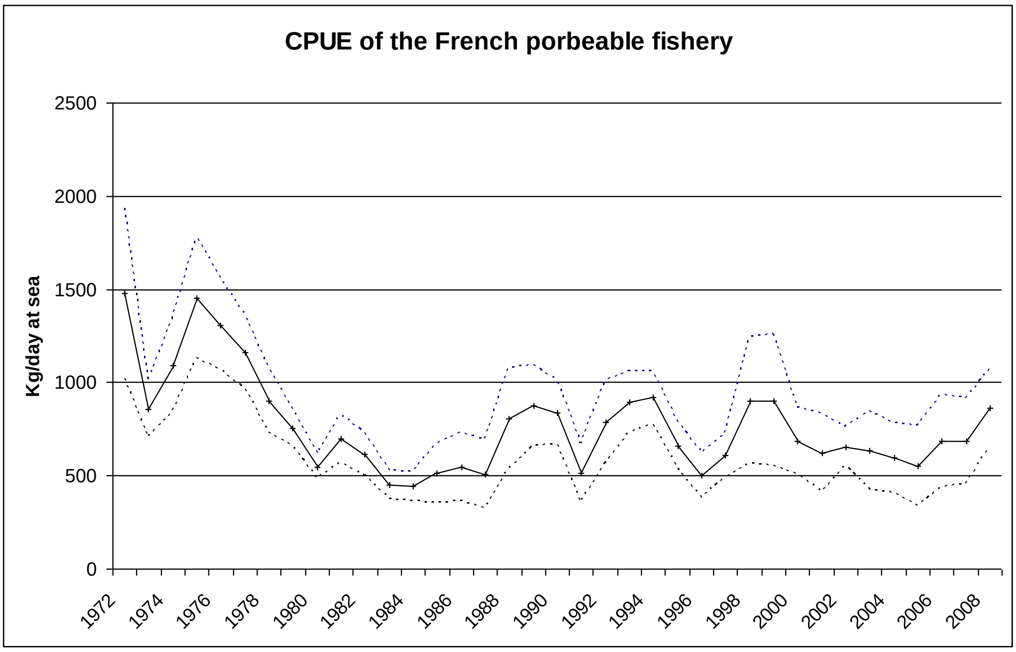

Figure 6.7. Porbeagle in the Northeast Atlantic. Nominal CPUE (kg/day at sea) for porbeagle taken in the French fishery (1972–2008) with confidence interval (±2 SE of ratio estimate). Source: Biais and Vollette (2009 WD).

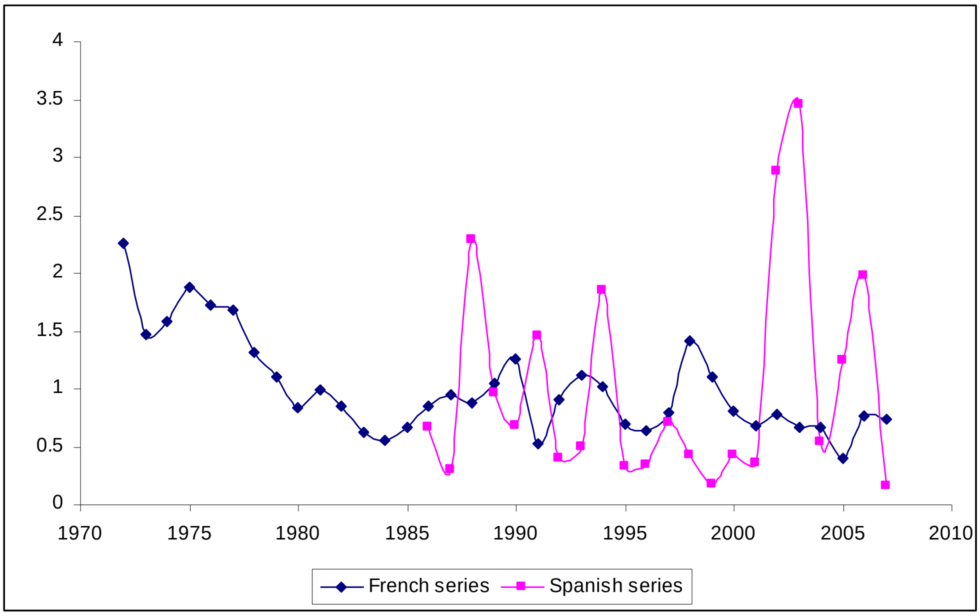

Figure 6.8. Porbeagle in the Northeast Atlantic. Temporal trends in standardized CPUE for the French target longline fishery for porbeagle (1972–2007) and Spanish longline fisheries in the Northeast Atlantic (1986–2007). Source: ICCAT (2009).

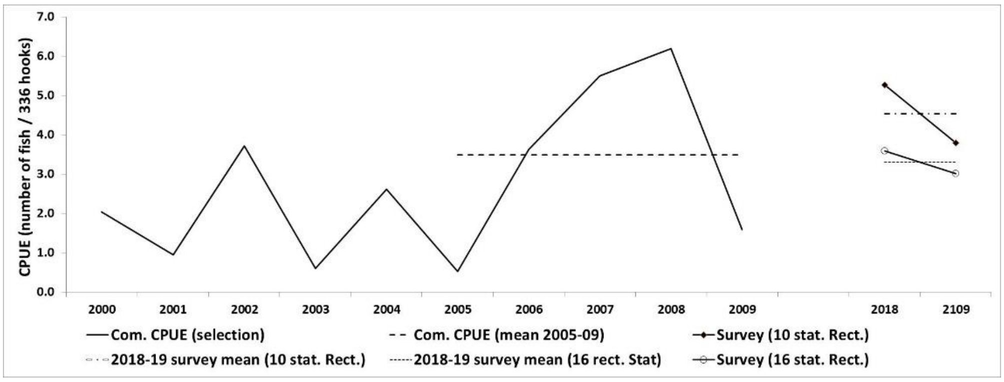

Figure 6.9. Porbeagle in the Northeast Atlantic. Survey CPUE (in number of porbeagles per long line set of 336 hooks) in 2018–2019 and the commercial CPUE series in 2000–2009 built with selections to make it comparable to the survey indices. Two survey CPUEs are shown, one for the entire survey area including 16 statistical rectangles and one including 10 statistical rectangles, which excluded those rectangles with mean CPUEs of less than 1 fish/336 hooks in 2018 or less than 1.5 fish/336 hooks in 2019. Source: Biais, 2019 WD.

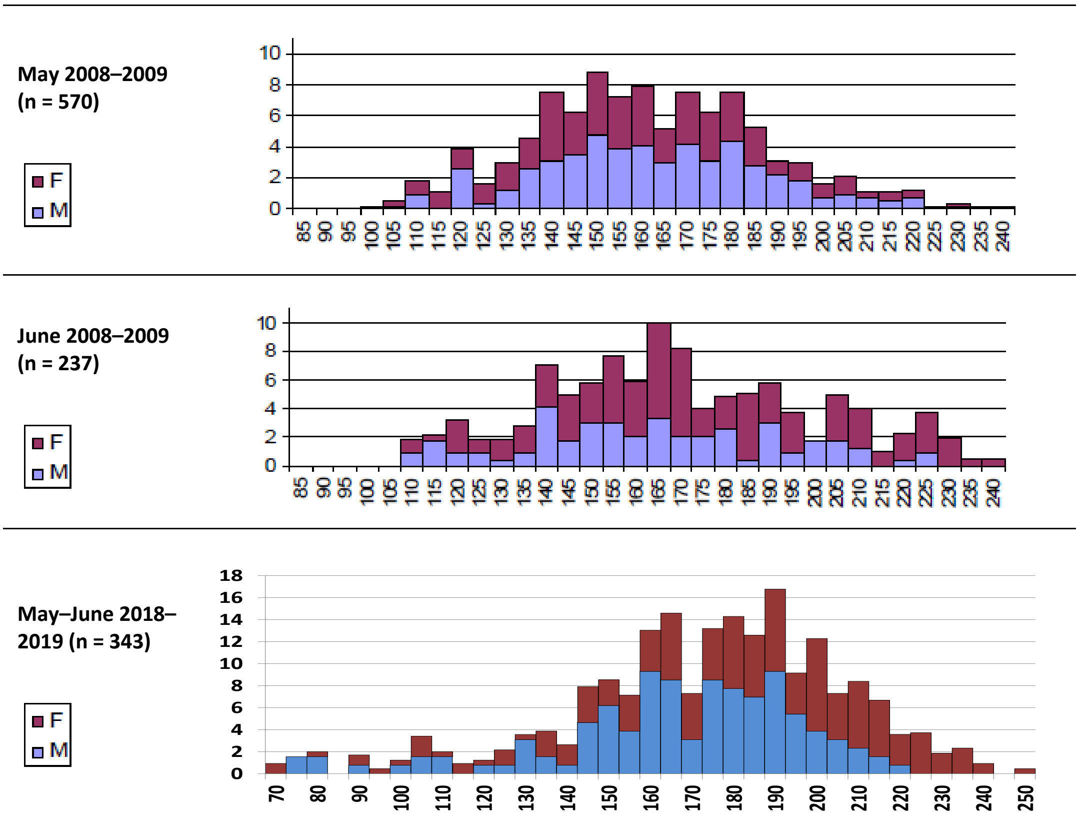

Figure 6.10. Porbeagle in the Northeast Atlantic. Length distribution (in %) of the porbeagle French catches in May and June 2008–2009 (source Hennache and Jung, 2010) and of the porbeagle survey in May and June 2018–2019 (source Biais, 2019 WD). Note: Length relates to curved fork length in cm.

7 Basking Shark in the Northeast Atlantic (ICES areas 1–14)

7.1 Stock distribution

In the Northeast Atlantic, the basking shark *Cetorhinus maximus* is present from Iceland, and the White Sea (southern Barents Sea) southwards to the Mediterranean Sea and north-west Africa (Compagno, 1984; Konstantinov and Nizovtsev, 1980) with known aggregation sites around the UK and Ireland (Sims, 2008). WGEF considers that the basking shark in the ICES area exists as a single stock and management unit. However, the WGEF is aware of tagging studies showing both transatlantic and transequatorial migrations, as well as migrations into tropical areas and mesopelagic depths (Gore *et al*., 2008; Skomal *et al*., 2009; Braun *et al*., 2018; Dewar *et al.* 2018). A genetic study by Hoelzel *et al*. (2006) indicates no differentiation between ocean basins, whereas Noble *et al*. (2006) suggested little gene flow between the northern and southern hemisphere.

There are two rough estimates of effective population size using genetics, one global, to take with caution, by Hoelzel *et al*. (2006), of 8200 individuals and one for the Irish Sea of 382 individuals. Lieber *et al*. (2019) suggest over 800 individuals frequenting Isle of Man waters at some point during the year. A recent study west of the UK, using photo identification (Gore *et al.*, 2016), showed very few re-sightings after one year (0.5%), and satellite tracking showed that basking shark show behavioural plasticity and that most individuals use only a small fraction of the time feeding in the surface (Gore *et al.*, 2016; Dohety *et al.*, 2017). These results point to a relatively large stock, and/or that the stock size may not be adequately traced by surface sightings.

7.2 The fishery

7.2.1 History of the fishery

The fishery for basking shark goes back as far as the middle or end of the 1700s, in Norwegian, Irish and Scottish waters (Strøm, 1762; Moltu, 1932; Parker and Stott, 1965; Myklevoll, 1968; McNally, 1976; Fairfax, 1998; See also the Stock Annex). Up to 1000 individuals may have been taken in Irish waters each year at the height of the fishery. Such intensive fisheries stopped during the mid-1800s when the species became very scarce.

The Norwegian fleet resumed the fishery in 1920. The landings increased during the 1930s as the fishery gradually expanded to offshore waters across the North Sea and south and west of Ireland, Iceland and Faroes. During 1959–1980, landings ranged between 1266 and 4266 individuals per year, but subsequently declined (Kunzlik, 1988). The geographical and temporal distribution of the Norwegian domestic basking shark fishery changed markedly from year to year, possibly as a consequence of the unpredictable nature of the shark's inshore migration (Stott, 1982).

In Irish waters, the basking shark fishery started again in 1947. Between 1000 and 1800 individuals were taken each year from 1951 to 1955 (an average of 1475 per year), but there was a decline in recorded landings from 1956. Average annual landings were 489 individuals from 1956–1960, 107 individuals from 1961–1965, then about 50–60 individuals per year for the remaining years of the fishery (Parker and Stott, 1965; McNally, 1976).

The Scottish fishery started in the 1940s. In all, around 970 sharks were taken between 1946 and 1953 (during a period when Norwegian vessels were also catching basking sharks in these waters).

From 1977–2007, an estimated total of 12 347 basking sharks were landed by Norway and Scotland, and of these Norway landed 12 014 individuals with an annual maximum of 1748 individuals landed in 1979.

There is no longer any directed fishery for basking shark within the ICES area. Since 2007, the species has been listed as a prohibited species on EU fisheries regulations (Council Regulation (EC) No 41/2006), for details and currently valid regulation see Section 7.2.4. Norwegian vessels have not reported landings since 2013, though they may land dead specimens but should release live specimens. Since 2013, reported landings have been < 1 tonne in total from all countries, with its maximum of 0.6 tonnes landed in 2017.

7.2.2 The fishery in 2020

No new information.

7.2.3 ICES advice applicable

ICES advice has been for a zero TAC since 2006. In 2012, ICES advised on the basis of the precautionary approach that there should be no landings of basking shark and that it should remain on the Prohibited Species List. In 2019, ICES advised that "*when the precautionary approach is applied for basking shark in the Northeast Atlantic, no targeted fisheries should be permitted and bycatch should be minimized. This advice is valid for 2020 to 2023*".

7.2.4 Management applicable

Article 14 of Council Regulation (EU) 2019/124 prohibits Union fishing vessels from fishing for, retaining on board, transhipping or landing basking shark in all waters. Article 50 of Council Regulation (EU) 2019/124 prohibits third-country vessels fishing for, retaining on board, transhipping or landing basking shark from EU waters.

Based on ICES advice, Norway banned all directed fisheries and landing of basking shark in 2006 in the Norwegian Economical Zone and in ICES subareas 1–14. The ban has continued since. During this period, live specimens caught as bycatch had to be released immediately, although dead or dying specimens could be landed. Since 2012, bycatch that is not landed should also be reported, and landings of basking sharks are not remunerated. Bycatch should be reported both in number of individuals and weight (since 2009).

Basking shark has been protected from killing, taking, disturbance, possession and sale in UK territorial (twelve nautical miles) waters since 1998. They are also protected in two UK Crown Dependencies: Isle of Man and Guernsey (Anon., 2002).

Sweden has forbidden fishing for or landing basking shark since 2004.

7.3 Catch data

7.3.1 Landings

Landings data within ICES subareas 1–14 from 1977–2020 are presented in Table 7.1, and Figure 7.1, since 2014: <1 t is landed. Landings of basking shark peaked in 1979 at a total of 5266 t, and declined rapidly towards 1988. Another peak in landings (1697 t) occurred in 1992. After the ban on directed fisheries in 2006–2007, annual landings declined to <30 t and are currently <1 t. Landings data from 1975–2014 by ICES subarea are shown in Figure 7.2.

Reported landings data come from UK (Guernsey) in 1984 and 2009, Portugal (1991–2007, 2010–2013, 2016), France (1990–2006, 2008–2010, 2014, 2017–2018) and Norway (1977–2008, 2011–2012). Most landings are from Subarea 2 and are taken by Norway. For Portugal and France, the reported landings were between 0.02 and 1.5 t. Landings for France in 2005 were higher, with 3.5 t.

Landings in numbers from Scotland and Norway (1977–2014) are presented in Figure 7.3. The trends are very similar to those of landings in biomass, with a first maximum of 1748 individuals in 1979, a second maximum of 573 individuals in 1992, and less than ten individuals after 2006.

The conversion factors used for Norwegian landings (liver and fin weight to live weight) were revised during WGEF 2008. Data from the Norwegian Directorate of Fisheries revealed that the nominal value of fins increased dramatically from 1979 to 1992, was variable during 1993–2005, and decreased after 2005. Table 7.2 shows old and revised numbers.

Table 7.3 shows the proportions (%) of landed basking sharks caught by various gears as reported to the Norwegian Directorate of Fisheries (1990–2011). During most of the 1990s, harpoon was the main gear, but remained at a relatively low level from 2000, except for 2005, which was the last year with a directed fishery. After the ban on directed fisheries in 2006, bycatch has been taken primarily in gillnets.

Further information on Norwegian landings of liver and fins, and corresponding official and revised landings in live weight and numbers are given in the Stock Annex.

7.3.2 Discards

Limited quantitative information exists on basking shark discarded bycatch. However, anecdotal information indicates that this species is an incidental bycatch in gillnet and trawl fisheries and may be entangled in potting ropes. Most bycatch events occur in the summer as the species moves inshore. Total bycatch has not been estimated.

Normal discard observer programmes, such as DCMAP may not record bycatch of large animals such as basking sharks, if they fall or are removed from gear before the catch is brought on board the vessel. Fisheries observer programmes are not designed to account for rare species. (ICES, 2018).

Berrow and Heardman (1994) estimated 77–120 sharks were caught annually in the gillnet fishery in the Celtic Sea. These authors received 28 reports of specimens being entangled in fishing gear around the Irish coast in 1993. In the Isle of Man, bycatch in herring and pot fishery (entanglement in ropes) is estimated at 14–20 sharks annually. Bonfil (1994) estimated that 50 specimens were taken annually by the oceanic gillnet fleet in the Pacific Ocean. Fairfax (1998) reported that basking sharks are sometimes brought up from deep-water trawls near the Scottish coast during winter, and Valeiras *et al.* (2001) reported that of twelve basking sharks being incidentally caught in fixed entanglement nets in Spanish waters between 1988 and 1998, three sharks were sold at landing markets, three live sharks were released, and three dead sharks were discarded at sea. More detailed information can be found in the Stock Annex.

The French NGO APECS reported on 15 accidental catches from the Irish Sea, Atlantic Ocean and Mediterranean Sea (Jung *et al.*, 2012). More detailed information (catch location, gear, and biological data) are given in Table 7.4. This table also includes data on eleven bycatch events from the Norwegian coast, published in the Norwegian media (prior to 2013).

Accidental bycatch of three basking sharks were reported from The Smalls, Ireland (Division 7.g) in 2005. These sharks were released alive (Johnston, pers. comm. 2015). There are no other records of basking sharks in the Irish discard observer programme.

There were two records of basking shark caught (and discarded) in the English and Welsh commercial fisheries (Silva and Ellis, 2019). Both female specimens were caught (and discarded) by gillnetters, in the western English Channel in 2002 (382 cm T_L) and in Bristol Channel in 2012 (378 cm T_L).

In 2009, observers from French national observer programmes reported three accidentally caught, but released, basking sharks (*ca.* 4 m long). Two basking sharks were recorded in Division 6.a and one in Division 4.a. One individual (*ca.* 8 m long) was recorded in 2010 from Division 6.a.

In April 2014, two basking sharks were stranded on south Brittany beaches: one male (5 m L_T, 650 kg) and one female (4 m L_T, 250 kg estimated). The female had a third of its dorsal body lacerated with a propeller.

Five basking sharks were caught and discarded by the Norwegian Coastal Reference Fleet in 2007–2009 (Vollen, 2010 WD). All specimens were caught in gillnets by vessels <15 m in ICES Subarea 2.

The requirement for EU fleets to discard all basking sharks accidentally caught results in a lack of information on these catches. Similarly, for Norway, although reporting of released basking sharks is mandatory, there is currently no operative mechanism to facilitate such reporting. A protocol for the standardised recording of bycatch and biological information from bycatch would benefit any future assessments of the stock.

7.3.3 Quality of the catch data

The official Norwegian conversion factor used to convert from liver weight and fin weight to live fish was revised in 2008 (Table 7.2). The official Norwegian landing statistics were unchanged from 1977 to 1999, but from 2000–2008 the revised landings figures are applied. Further information on the revision of the conversion factor is included in the Stock Annex.

7.3.4 Discard survival

Limited information available, and national observer programmes could usefully collect data on fate (released alive/released dead) of basking shark specimens caught.

7.4 Commercial catch composition

There is some information on minimum, maximum and median weight of livers and fins, and corresponding live weights of individual basking sharks landed in Norway during 1992–1997. This information is included in the Stock Annex.

7.5 Commercial catch-effort data

There are no effort or CPUE data available for recent years. Historical CPUE data from the Norwegian fishery (1965–1985) are given in the Stock Annex.

7.6 Fishery-independent surveys

Several countries, e.g. Norway, Denmark, Ireland, conduct scientific whale-counting surveys. Observations of basking sharks are normally recorded in these surveys.

The Norwegian whale-counting survey observed a total of 87 basking shark in the Norwegian Sea during the period 1995–2014. Sightings seem to be heavily dependent on weather conditions, and 82 of the 87 sightings were made within nine short time periods (hours or 1–2 d). No apparent trends could therefore be identified. A number of Norwegian commercial vessels regularly report observations of whales, and a request to report basking shark sightings might yield useful effort-related data. The Norwegian Shark Alliance (HAI Norge) has collected online public sightings of basking sharks from 2011–2014. The Institute of Marine Research (IMR) started collecting public sighting data through an online reporting system from summer 2019 and bycatch incidents from media reports, and validated data will be provided in 2020.

A national sightings program also exists along French coastlines, including all scientific survey reports (managed by APECS). Between 40 and 270 sightings are recorded each year, mostly reported by sailors and fishers. Sightings occur mainly from April to June, and the major area is the southern and western coasts of Brittany. Early sightings are reported off the island of Corsica in February–March; in 2011 one basking shark was reported in Saint Pierre et Miquelon.

There are sightings programmes in the UK (Marine Conservation Society, 2003; Southall *et al.*, 2005; and the Shark Trust, https://recording.sharktrust.org/sightings/search_database), and in Ireland through the Irish Basking Shark Study Group and the Irish Whale and Dolphin Group.

In Scotland, Whale and Dolphin Trust for Hebrides and North West Scotland, runs a sighting programme; Sea Watch Foundation is doing so for the Northern islands and northeast Scotland coasts. Basking Shark Scotland collates public sightings data.

7.7 Life-history and other relevant information

A summary of the knowledge of basking shark habitat, reproduction, growth and maturity, food and feeding, and behaviour can be found in the Stock Annex.

Basking sharks undertake extensive horizontal and vertical movements throughout the year (Sims *et al*. 2003; Sims, 2008) with a variety of spatio-temporal movement patterns and distances (Doherty *et al*., 2019; Dolton *et al*., 2020) and seasonal patterns (Doherty *et al*., 2019). Marked interannual and intra-annual variability of basking shark sightings have been reported, with significant correlation between the duration of the sightings season in each year and environmental/climatic factors like the North Atlantic Oscillation (Couto *et al*., 2017; Witt *et al*., 2012).

The Irish and Celtic Seas are important areas and studies show important migration corridors for sharks moving between NW Scotland, Isle of Man, SW England and western France (Berrow and Johnston, 2010 WD; Stéphan *et al*., 2011, Lieber *et al*., 2019).

In a study from 2008, the Irish Basking Shark Study Group tagged two basking sharks with archival satellite tags (Berrow and Johnston, 2010 WD). Both sharks remained on the continental shelf for most of the tagging period; 'Shark A' spent most time in the Irish and Celtic Seas with evidence of a southerly movement in winter to the west coast of France, whilst the movements of 'Shark B' were more constrained, remaining off the southwest coast for the whole period with locations off-the-shelf edge and in the Porcupine Bight (Figure 7.4). The greatest depths recorded were 144 m and 136 m, respectively, demonstrating that although 'Shark B' was located over deep water off-the-shelf edge, it was not diving to large depths. The sharks were within 8 m of the surface for 10% and 6% of the time. The study demonstrated that basking sharks were present and active in Irish waters throughout the winter period.

Skomal *et al.* (2009) shed further light on apparent winter 'disappearance' of basking shark. Through satellite archival tags and a novel geolocation technique they demonstrated that sharks tagged in temperate feeding areas off the coast of southern New England moved to the Bahamas, the Caribbean Sea, and onward to the coast of South America and into the southern hemisphere.

When in these areas, basking sharks descended to mesopelagic depths (200–1000 m) and in some cases remained there for weeks to months at a time. The authors concluded that basking sharks in the western Atlantic Ocean, which is characterized by dramatic seasonal fluctuations in oceanographic conditions, migrate well beyond their established range into tropical mesopelagic waters. In the eastern Atlantic Ocean, however, only occasional dives to mesopelagic depths have been reported in equivalent tagging studies (Sims *et al.*, 2005). It is hypothesized that in this area, the relatively stable environmental conditions mediated by the Gulf Stream may limit the extent to which basking sharks need to move during winter to find sufficient food.

The NGO APECS and the Manx Basking Shark Watch tagged ten basking sharks in 2009 (Stéphan *et al.*, 2011). The sharks were tagged with pop-up archival tags (MK10PAT, Wildlife Computers). Eight tags were deployed around the Isle of Man in the Irish Sea and two in the Iroise Sea (West Brittany, France). All the sharks tagged in the Irish Sea moved south, within the Irish Sea or Celtic Sea, and one to the southern Bay of Biscay (Figure 7.5). One of the tags set in the Irish Sea in 2009 popped off after five days but the second after 38 days. During this short period, the shark moved quickly northwards past the west coast of Ireland to western Scotland. This study confirmed that at least some sharks are present in coastal waters during the cold season (October to March). They are then found in deeper waters, while continuing to perform daily vertical migrations. However, one particularly significant sector of winter distribution does emerge: the northwestern part of the Celtic Sea where basking sharks are especially distributed at depths of 50–100 m during the cold season (Figure 7.5). The track of one shark tagged in Brittany confirms that some sharks sighted at the entrance to the Channel can swiftly reach the waters of the Hebrides via the west of Ireland (Figure 7.5).

Since 2011, APECS have tagged two further sharks off south Brittany, a 7.5 m male in April 2011 and a 6.5 m female in June 2013. These tags popped off after 35 and 76 days, respectively. The first one moved about 150 nm west of the tagging location to the northern Bay of Biscay, and the second one in the Celtic Sea, about 40 nm south of Ireland. In May 2016, two SPOT tags were deployed on adult animals south of Brittany; the 6.5 m female showed up in May 2017 in the southern of Bay of Biscay after spending the winter off the Moroccan coast.

The Manx Basking Shark Watch also deployed tags in 2008 and 2011–2013 and have four basking sharks equipped with SPOT5 tags that can be tracked on the Wildlife Tracking website. The Irish Basking Shark Study Group also performed tagging in 2012 and 2013.

SPOT Tagging technology has been successfully applied in the Inner Hebrides (West Scotland) on basking shark since 2012: nine SPOTs were deployed in July 2012 (Witt *et al.*, 2013). Recent analyses (Witt *et al.*, 2016), revealed various spatio-temporal patterns in habitat use, from coastal movements to movements of thousands of kilometres (Figure 7.6). Long-distance movements of three adult basking shark from the Hebridean Sea to Madeira, Canary Islands and North African coasts were observed from SPOT and SPLASH-F tags. These represented movements of >3300 km (straight-line distance) over periods of 132–322 days. In contrast, other sharks demonstrated a degree of site fidelity to the Inner Hebrides (at various spatial scales) during the summer months (Figure 7.7). This study also lighted the importance of the Irish and Celtic Seas and important migration corridors for sharks moving from NW Scotland to the Isle of Man and southwest England.

7.8 Exploratory assessment models

No exploratory assessments have been undertaken.

7.9 Stock assessment

No stock assessment has been undertaken.

7.10 Quality of assessments

No assessments have been undertaken.

7.11 Reference points

No reference points have been proposed for this stock.

7.12 Conservation considerations

Basking shark is listed as "Endangered" on the Red List of European marine fish (Nieto *et al.*, 2015) and on the Norwegian Red List (Sjøtun *et al.,* 2010).

Basking shark was listed on Appendix II of the Convention on International Trade in Endangered Species (CITES) in 2002.

Basking shark was listed on Appendices I and II of the Convention on the Conservation of Migratory Species (CMS) in 2005.

Basking shark is listed on Annex I, Highly Migratory Species, of the UN Convention on the Law of the Sea (UNCLOS).

Basking shark was listed on the OSPAR (Convention on the protection of the marine environment of the Northeast Atlantic) list of threatened and/or declining species in 2004.

7.13 Management considerations

The current status of the stock is unknown. At present, there is no directed fishery for this species. Section 7.2.4 describes current fisheries management. WGEF considers that no directed fishery should be permitted unless a reliable estimate of a sustainable exploitation rate is available.

Proper quantification of bycatch, fate and discarding, in numbers and estimated weight, is required.

Where national legislation prohibits landing of bycaught basking sharks, measures should be put in place to ensure that incidental catches are recorded by (estimated) weight and number, and carcasses or biological material made available for research.

7.14 References

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Table 7.1. Basking shark in the Northeast Atlantic. Total landings (t) of basking sharks in ICES subareas 1–14 (1977–2020)*. "."=zero catch, "+" = <0.5 t. Data for 2020 updated following Data Call.

Year	1 & 2	3 &4	5a	5b	6	7	8	9	10	12	14	TOTAL
1977	3680	.	.	.	.	.	.	.	.	.	.	3680
1978	3349	.	.	14	.	278	.	.	.	.	.	3641
1979	5120	.	.		.	139	7	.	.	.	.	5266
1980	3642	.	.	83	.	.	.	.	.	.	.	3725
1981	1772	.	.	28	.	.	.	.	.	.	.	1800
1982	1970	.	.	.	.	186	.	.	.	.	.	2156
1983	967	734	.	.	.	60	.	.	.	.	.	1761
1984	873	1188	.	.	.	1	.	.	.	.	.	2062
1985	1465	.	.	.	.	.	.	.	.	.	.	1465
1986	1144	.	.	.	.	.	.	.	.	.	.	1144
1987	164	.	.	.	.	.	.	1	.	.	.	165
1988	96	10	.	.	.	.	.	.	.	.	.	106
1989	593	.	.	.	.	.	.	+	.	.	.	593
1990	781	116	.	.	.	.	1	.	.	.	.	897
1991	533	220	.	.	.	.	+	+	.	.	.	753
1992	1613	84	.	.	.	.	+	+	.	.	.	1697
1993	1374	.	.	.	.	.	.	+	.	.	.	1374
1994	920	157	.	.	.	.	+	1	.	.	.	1078
1995	604	23	.	.	.	.	1	1	.	.	.	629
1996	792	.	.	.	.	.	+	1	.	.	.	793
1997	425	43	.	.	.	.	2	1	.	.	.	471
1998	55	.	.	.	.	.	1	.	.	.	.	56
1999	31	.	.	.	.	.	1	1	.	.	.	33
2000	117	.	.	.	.	.	1	1	.	.	.	119
2001	80	.	.	.	.	.	.	2	1	.	.	83
2002	54	+	.	.	.	.	.	1	.	.	.	55
2003	128	.	.	.	.	.	.	1	.	.	.	129
2004	72	.	.	.	.	.	.	1	26	.	.	99
2005	218	+	.	.	.	2	1	2	.	.	.	223
2006	16	.	.	.	.	+	+	+	.	.	.	17
2007	26	.	.	.	.	.	.	+	.	.	.	26
2008	4	.	.	.	.	.	1	.	.	.	.	5
2009	.	.	.	1	+	.	+	.	.	.	.	1
2010	.	.	.	+	1	.		+	.	.	.	1
2011	2	.	.	.	.	.	.	+	.	.	.	2
2012	22	.	.	.	.	.	.	1	.	.	.	24
2013	.	.	.	.	.	.	.	+	.	.	.	+
2014	.	.	.	.	.	+	.	.	.	.	.	+
2015	.	.	.	.	.	.	.	.	.	.	.	.

Year	1 & 2	3 &4	5a	5b	6	7	8	9	10	12	14	TOTAL
2016	.	.	.	.	.	.	.	+	.	.	.	+
2017	.	.	.	.	.	1	.	.	.	.	.	1
2018	.	.	.	.	.	.	.	.	.	.	.	.
2019	.	.	.	.	.	.	.	.	.	.	.	.
2020	.	.	.	.	.	+	.	+	.	.	.	+

*** The figures in the table are rounded. Calculations were done with unrounded inputs and computed values may not match exactly when calculated using the rounded figures in the table.**

Table 7.2. Basking shark in the Northeast Atlantic. Norwegian landings of liver (kg) and fins (kg) of basking shark (*Cetorhinus maximus*) during 1977–2008, estimated landings in live weight (conversion factors of 4.64 for liver and 40.0 for fins), estimated numbers of landed individuals (from landings of both liver and fins using an average weight per individual of 648.5 kg for liver and 71.5 kg for fins), ICES and Norwegian official landings (applying conversion factors of 10.0 for liver (1977–1995), 100.0 fins (1996–1999), 100.0 for fins (ICES 2000–2008), and 40.0 for fins (Norway 2000–2008)), and landings recommended used by ICES WGEF 2008. In 1995 and 1997, landings of whole individuals measuring 3760 kg (one individual) and 7132 kg (two individuals), respectively, were reported. These weights are included in the official and revised landings and in the estimation of landed numbers.

Year	Liver (kg)	Fins (kg)	Catch from liver (tonnes)	Catch from fins (tonnes)	Landed numbers (livers – fins)	ICES official landings (tonnes)	Norway official landings (tonnes)	Recommended by ICES WGEF 2008
1977	793 153	0	3680.2	0.0	1223	7931.5	7931.5	3680.2
1978	784 687	0	3640.9	0.0	1210	7846.9	7846.9	3640.9
1979	1 133 477	95 070	5259.3	3802.8	1748–1330	11 334.8	11 334.8	5259.3
1980	802 756	60 851	3724.8	2434.0	1238–851	8027.6	8027.6	3724.8
1981	387 997	27 191	1800.3	1087.6	598–380	3880.0	3880.0	1800.3
1982	464 606	31 987	2155.8	1279.5	716–447	4646.1	4646.1	2155.8
1983	379 428	24 847	1760.5	993.5	585–348	3794.3	3794.3	1760.5
1984	444 171	23 505	2061.0	940.2	685–329	4441.7	4441.7	2061.0
1985	315 629	16 699	1464.5	668.0	487–234	3156.3	3156.3	1464.5
1986	246 474	12 138	1143.6	485.5	380–170	2464.7	2464.7	1143.6
1987	35 244	3148	163.5	125.9	54–44	352.4	352.4	163.5
1988	22 761	1927	105.6	77.1	35–27	227.6	227.6	105.6
1989	127 775	10 367	592.9	414.7	197–145	1277.8	1277.8	592.9
1990	193 179	18 110	896.4	724.4	298–253	1931.8	1931.8	896.4
1991	162 323	18 337	753.2	733.5	250–256	1623.2	1623.2	753.2
1992	365 761	37 145	1697.1	1485.8	564–520	3657.6	3657.6	1697.1
1993	291 042	34 360	1350.4	1374.4	449–481	2910.4	2910.4	1374.4
1994	176 220	26 922	817.7	1076.9	272–377	1762.2	1762.2	1076.9
1995	10 450	15 571	52.2	626.6	17–219	108.3	108.3	626.6
1996	41 283	19 789	191.6	791.6	64–277	1978.9	1978.9	791.6
1997	57 184	11 520	272.5	467.9	90–163	1159.1	1159.1	467.9

Year	Liver (kg)	Fins (kg)	Catch from liver (tonnes)	Catch from fins (tonnes)	Landed numbers (livers – fins)	ICES official landings (tonnes)	Norway official landings (tonnes)	Recommended by ICES WGEF 2008
1998	3	1366	0.0	54.6	19	136.6	136.6	54.6
1999	20	770	0.1	30.8	11	77.0	77.0	30.8
2000	51	2926	0.2	117.0	41	292.6	117.0	117.0
2001	0	1997.5	0.0	79.9	28	199.7	79.9	79.9
2002	0	1351.5	0.0	54.1	19	135.2	54.1	54.1
2003	0	3191.5	0.0	127.7	45	319.2	127.7	127.7
2004	0	1808.3	0.0	72.3	25	180.8	72.3	72.3
2005	0	2180.5	0.0	87.2	30	218.1	87.2	87.2
2006	0	160	0.0	6.4	2	16.0	6.4	6.4
2007	0	653	0.0	26.1	9	65.3	26.1	26.1
2008	0	98	0.0	3.9	1	9.8	3.9	3.9

Table 7.3. Basking shark in the Northeast Atlantic. Proportions (%) of landed basking sharks caught in different gears as reported to the Norwegian Directorate of Fisheries from 1990–2011.

Year	Division 2.a							Division 4.a	
	Harpoon	Gillnet	Driftnet*	Undefined nets	Bottom trawl	Danish seine	Hook and lines	Harpoon	Gillnet
1990	84.0		3.1					12.9	
1991	69.7		1.0					29.3	
1992	83.1		6.0		5.6		0.4	4.9	
1993	99.1	0.8			0.1				
1994	85.4							14.6	
1995	89.8	6.5							3.7
1996	89.1	10.3		0.2		0.4	0.1		
1997	66.7	23.7					0.5	9.1	
1998	67.2	28.5					4.4		
1999	9.1	81.8		7.8	1.3				
2000	33.4	58.7			7.8				
2001		96.0			4.0				
2002	16.3	78.5			5.2				
2003	3.4	89.7			7.2				
2004		100.0							
2005	54.1	44.5		0.5	1.4				
2006		100.0							
2007		100.0							
2008		100.0							
2009									
2010									
2011		50.0					50.0		

*** These driftnets for salmon were banned after 1992.**

Table 7.4. Basking shark in the Northeast Atlantic. Summary details of bycatch reported from France and Norway.

Nation	Day	Month	Year	Geog. area	Lat	Lon	Gear	Depth	Length	Weight (kg)	Comment	Source
France		May	2009	Mediterranean	42.935	3.063	Gillnet		6–7 m			Unpublished data - APECS
France		May	2009	Mediterranean	42.935	3.063	Gillnet		6–7 m			Unpublished data - APECS
France		May	2009	Mediterranean	42.935	3.063	Gillnet		6–7 m			Unpublished data - APECS
France	31	May	2009	Atlantic	47.768	4.211			2.5–3 m		Released alive	Unpublished data - APECS
France	18	Nov	2009	Atlantic	43.427	1.695			3.5–4 m		Discarded	Unpublished data - APECS
France	27	Apr	2009	Mediterranean	45.841	1.531	Bottom trawl	20 m			Discarded	Unpublished data - APECS
France	20	May	2009	Mediterranean	43.051	-3.391	Pelagic trawl	45 m	5 m		Discarded	Unpublished data - APECS
France	25	Jan	2010	Iroise Sea	48.549	5.124	Gillnet		4–5 m		Released alive	Unpublished data - APECS
France	8	May	2010	Atlanic	46.236	1.592	Gillnet		4.6 m		Discarded	Unpublished data - APECS
France	27	May	2010	Atlantic	47.247	2.964	Gillnet		3.4 m		Discarded, samples, museum collection	Unpublished data - APECS
France	30	May	2011	Mediterranean	43.328	-5.203	Gillnet		3–6 m		Released alive	Unpublished data - APECS
France	3	Aug	2011	Iroise Sea	48.233	4.483	Gillnet		3–6 m		Discarded, samples	Unpublished data - APECS
France	19	Apr	2011	Atlantic	47.760	4.205	Gillnet	30 m	3–6 m		Discarded, samples, immature	Unpublished data - APECS
France	6	May	2011	Atlantic	47.745	4.218	Gillnet		3–6 m		Released alive, genetic sample	Unpublished data - APECS
France	4	Nov.	2011	Celtic Sea					4 m		Genetic sample	Obsmer data
France	17	May	2013	Atlantic	47.780	4.210	Gillnet		3.3 m		Discarded, samples, immature male	Unpublished data - APECS
France	15	April	2014	Atlantic	47.78	3.77			5 m	650	Discarded	Media
Norway		Dec	2006	Atlantic	59.03	9.80	Gillnet	50 m	3.5 m	350	Approx. position	Media
Norway		Sep	2006	Atlantic	58.81	9.90	Gillnet		~4 m	500	Discarded, approx. position	Media
Norway		Aug	2007	Atlantic	61.97	5.02	Gillnet		4.5 m	250	Discarded, approx. position	Media
Norway			2007	Atlantic	64.13	8.20	Gillnet		4 m	500	Approx. position	Media
Norway		Sep	2007	Atlantic	58.45	8.86	Gillnet		4–5 m		Approx. position	Media
Norway		July	2008	Atlantic	68.11	14.18					Approx. position	Media
Norway		July	2008	Atlantic	62.36	47.00	Gillnet				Released alive, approx. position	Media

Nation	Day	Month	Year	Geog. area	Lat	Lon	Gear	Depth	Length	Weight (kg)	Comment	Source
Norway		July	2011	Atlantic	70.29	27.28	Gillnet		~10 m		Discarded, approximate position	Media
Norway		July	2011	Atlantic	71.11	23.96	Gillnet				Released alive, approx. position	Media
Norway		May	2012	Atlantic	68.78	11.86	Gillnet		~10 m	~1 t	Landed, approx. position	Media
Norway		May	2012	Atlantic	62.48	5.86	Gillnet				Landed, approx. position	Media
Norway	13	Sept	2014	Atlantic	65.60	12.10	Gillnet		12 m		Approx. position	Media

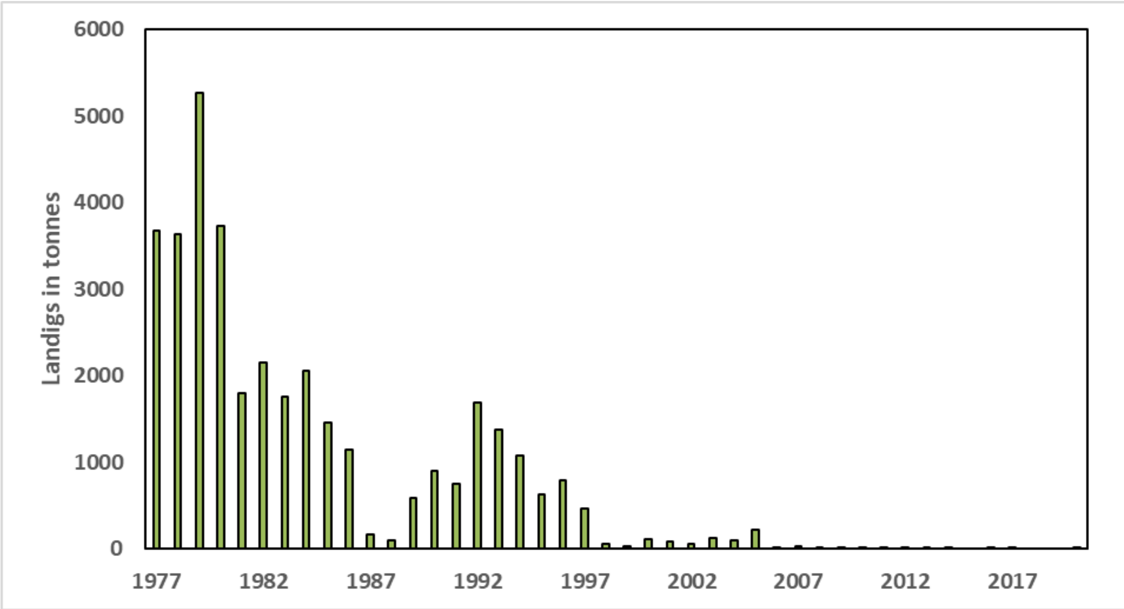

Figure 7.1. Basking shark in the Northeast Atlantic. Total landings (1000 t) of basking sharks in ICES subareas 1–14 from 1977–2020, since 2013: < 1 t landed.

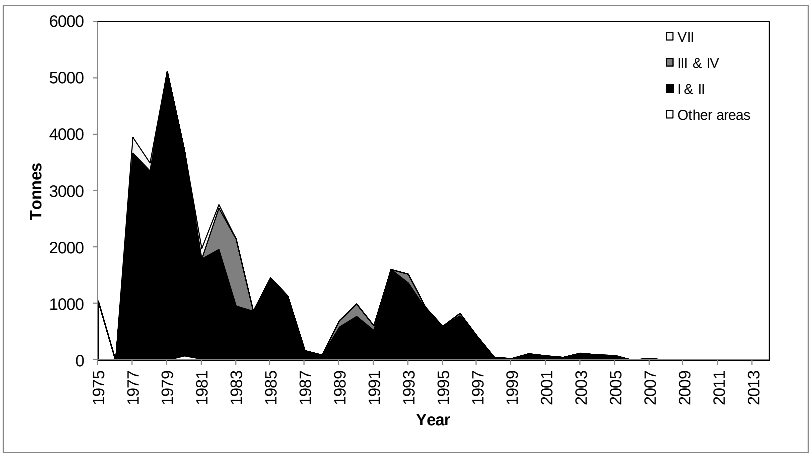

Figure 7.2. Basking shark in the Northeast Atlantic. Total landings (t) of basking sharks by ICES subareas (1–14) from 1975–2014.

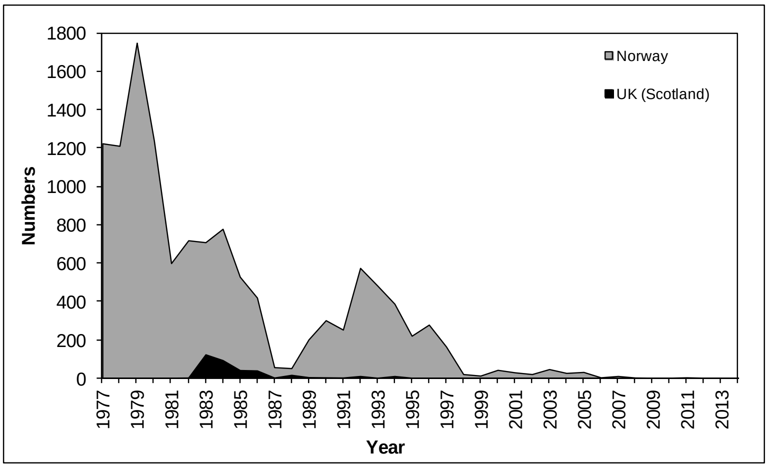

Figure 7.3. Basking shark in the Northeast Atlantic. Numbers of basking sharks landed by Norway and Scotland in ICES subareas 1–14 from 1977–2014.

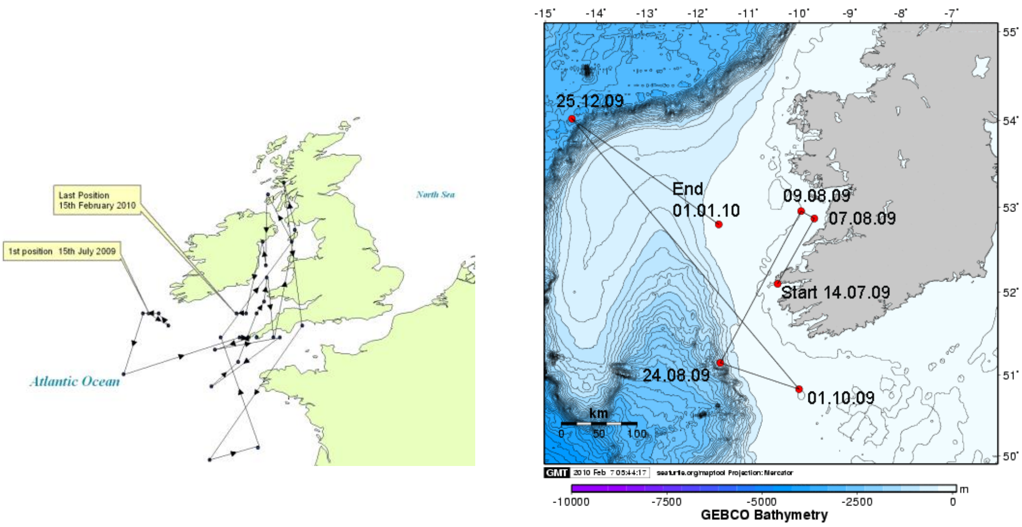

Figure 7.4. Basking shark in the Northeast Atlantic. Geolocations from basking shark A (left, sex = male) and B (right, sex = unknown). Source: Berrow and Jackson (2010 WD).

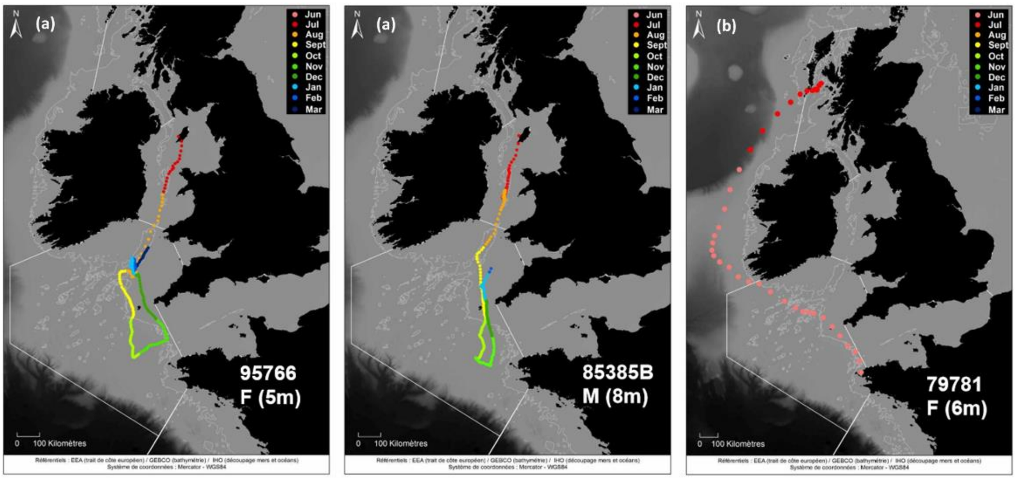

Figure 7.5. Basking shark in the Northeast Atlantic. Most probable tracks for (left) shark 95766 (5 m female) and (centre) shark 85385 (8 m male), tracked for more than 200 days and which stayed in the Irish Sea and Celtic Seas, and (right) most probable track for shark 79781 (6 m female) tracked for 38 days. Source: Stéphan *et al.* (2011).

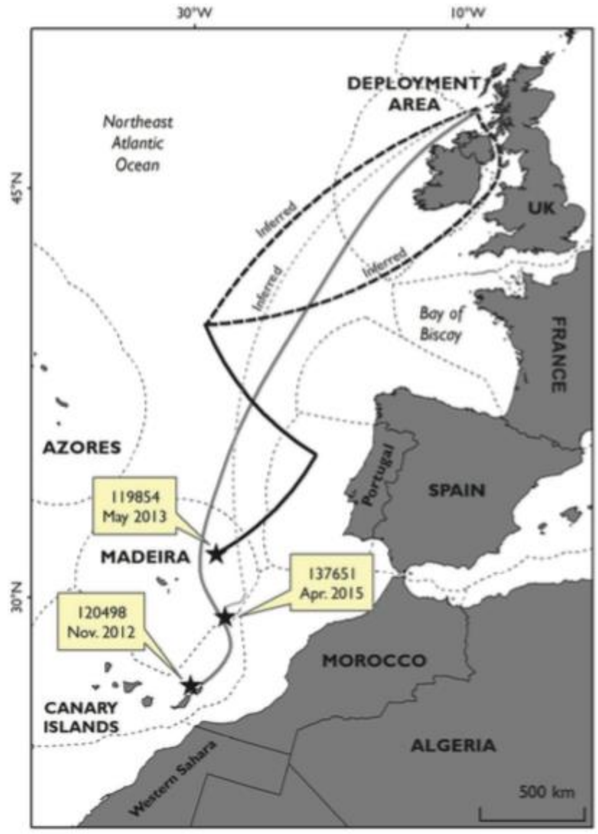

Figure 7.6. Basking shark in the Northeast Atlantic. Long-range movements of basking sharks from Scotland revealed by Argos satellite tracking. Two SPOT-tagged basking sharks in 2012 (119854, 120498) and one SPLASH-F tagged shark in 2014 (137651). Source: Witt *et al.* (2016).

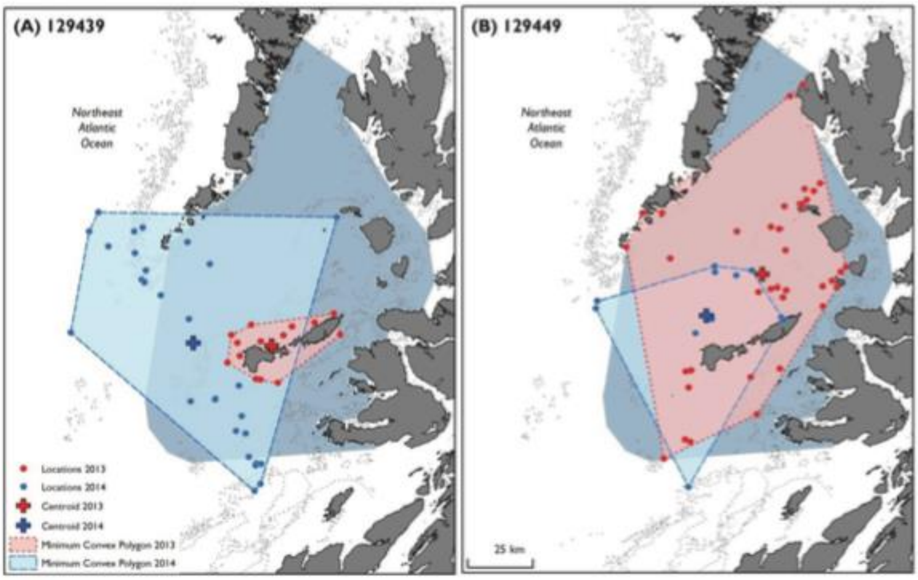

Figure 7.7. Basking shark in the Northeast Atlantic. Example distribution of two sharks showing inter-annual fidelity to the Hebridean Sea. Single highest quality Argos locations per day (red and blue circles for 2013 and 2014 respectively). Minimum convex polygons for data gathered in 2013 and 2014 (red and blue polygons respectively), geographic mean centroid of Argos locations for 2013 and 2014 (red and blue crosses respectively). Source: Witt *et al.* (2016).

8 Blue shark in the North Atlantic (North of 5ºN)

8.1 Stock distribution

There is a discrete North Atlantic stock of blue shark *Prionace glauca* (Heessen, 2003; Fitzmaurice *et al*., 2005; ICCAT, 2008), with 5°N latitude as the southern stock boundary, and a separate South Atlantic stock (ICCAT, 2008). This delineation is based on mark-recapture data and oceanographic features. In addition, this division facilitates comparison with fisheries statistics of other North Atlantic stocks, such as tuna-like species, that have the same southern stock boundary. Hence, the ICES area is only part of the stock area.

Recent genetic studies on blue shark reveal genetic homogeneity across whole ocean basins in Atlantic (Verissimo *et al*., 2017) and Pacific oceans (Ovenden *et al*., 2009; Taguchi *et al*., 2015). These are at odds with the currently assumed distinction of northern and southern stocks within each ocean basin. The bulk of the evidence gathered thus far indicates that the blue shark exhibits dispersal with gene flow over very large spatial scales, and little to no philopatry to the sampled nursery areas or to distinct ocean basins. However, in cases as in blue sharks where effective populations sizes are ~1000s, the levels of genetic divergence associated with migration rates which could lead to demographic connectivity (~10%; Hastings, 1993) may be difficult to detect using traditional molecular markers. In these cases, the precautionary approach in conservation and fisheries management would be to consider each nursery area as independent, with potentially different demographic parameters and vulnerability to fishing pressure. If each nursery area currently exchanges only a few migrant individuals per generation with other nurseries, the replenishment of each stock would be mostly dependent on recruit survival rather than on immigration from adjacent stocks.

8.2 The fishery

8.2.1 History of the fishery

In recent years, more information has become available about fisheries taking blue shark in the North Atlantic. Although available data are incomplete, they offer information on the situation in fisheries and trends. There are no large-scale target fisheries for blue shark, but it is a major bycatch in tuna and billfish fisheries, where it can comprise up to 70% of the total catches and even exceed the catch of target species (ICCAT, 2005). In the North Atlantic, EU fleets (Portugal and Spain) are responsible for approximately 82% of the total landings (Anon., 2015).

Observer data indicates that substantially more blue sharks are caught as bycatch than reported in landings statistics. Blue sharks are also caught, in considerable numbers, in recreational fisheries, including in the ICES area (Campana *et al*., 2005).

Since 1998, there has been a Basque artisanal longline fishery targeting blue shark and other pelagic sharks in the Bay of Biscay from June to November (Díez *et al*., 2007). Initially 3–5 vessels were involved but, as a consequence of changes in local fishing regulations, the number of vessels has reduced to two after 2008.

In the North Atlantic, thirteen fisheries (in descending order of volume: EU-Spain, EU-Portugal, Japan, Canada, USA_LL, Chinese Taipei, EU-France, Belize, Panama, USA_SP., China PR, Korea and, Venezuela) accounted for 99% of the total removals (1990–2014). The majority (except: USA sport fishery, EU-France unclassified gear) are longline fisheries (Anon., 2015). There are also blue shark landings in Mediterranean fisheries (Anon., 2015).

In 2015, prior to their most recent stock assessment, ICCAT nominal catch statistics of blue shark (by stock, flag and gear) were reviewed. No major updates were made to the historical catch series, and only recent years of official catches were updated. Before 1997, there was a lack of official catch statistics for some of the main fishing nations operating in the stock area.

8.2.2 The fishery in 2020

No new information.

No major changes noted in 2020, although potential changes to fishing effort caused by the effects of COVID-19 have not yet been quantified.

8.2.3 Advice applicable

ACOM has never provided advice for blue shark in the ICES area. Assessment of this stock is considered to be the responsibility of ICCAT. In July 2015, members of WGEF participated in the ICCAT blue shark stock assessment meeting that took place in Lisbon, Portugal (ICCAT, 2015).

In 2015, ICCAT considered that the status of the North Atlantic stock is unlikely to be either overfished or subject to overfishing. However, due to the level of uncertainty in the assessment results no specific management recommendations were provided (ICCAT, 2015).

ICCAT adopted Rec. 16-12, which in paragraph 2 establishes a catch limit for blue sharks in the North Atlantic (39,102 t as the average of two consecutive years). This measure came into being in 2017 and the Standing Committee on Research and Statistics (SCRS) has been in a position to assess the effect of this measure as yet. However, SCRS data show that preliminary catches in 2017 and 2018 were 39 675 t and 33 853 t, respectively (SCRS, 2019).

In 2019, these catch limits were further refined when ICCAT adopted Rec. 19-07. This states that: "*An annual TAC of 39 102 t for North Atlantic blue shark is established. The annual TAC may be revised subject to a decision of the Commission based on the updated advice of the SCRS in 2021, or at an earlier stage if enough information is provided by the SCRS*". Catch limits for the EU, Japan and Morocco were set at 32 578 t, 4 010 t and 1 644 t, respectively, with all other CPCs to "*endeavour to maintain their catches at recent levels*".

8.2.4 Management applicable

There are no measures fully regulating all the catches of blue shark in the North Atlantic.

European regulations for annual fishing opportunities have given an overall TAC (39 102 t) for blue shark in the Atlantic Ocean north of 5°N since 2017. Whilst this nominal TAC has remained unchanged, an allocation key was included in the 2020 fishing opportunities (Council Regulation (EU) 2020/123), under which the EU quota was set at 32 578 t (83.3% of the 39 102 t TAC, and in accordance with ICCAT Rec. 19-07), and this was allotted to Spain (27 062 t), Portugal (5 363 t), France (152 t) and Ireland (1 t).

EC Regulation No. 1185/2003 (updated by EU Regulation No 605/2013) prohibits the removal of shark fins of these species, and subsequent discarding of the body. This regulation is binding on EC vessels in all waters and non-EC vessels in Community waters.

8.3 Catch data

8.3.1 Landings

It is difficult to accurately quantify landings of blue shark in the North Atlantic. Data are incomplete, and the generic reporting of shark catches has resulted in underestimations. Landing data from different sources (ICCAT, FAO and national statistics) can vary (Figures 8.1–8.3). Table 8.1 gives the catch data (total landings and discards by stock, flag and major gears) collated by ICCAT, which appears to provide the most complete catch data for this stock, though there can be small changes in these data over time (Tables 8.2–8.3). ICCAT considers that reported landings of blue shark were underestimated in the early part of the time-series (prior to 1997), with official landings and estimates of a comparable magnitude since 1997, when annual landings have been *ca.* 20 000–40 000 t. In the North Atlantic, blue shark is reported predominantly by Spain, Portugal, Japan, USA and Canada (Figure 8.1).

In 2015, alternative approaches to estimate catch series were discussed by ICCAT (Anon., 2015), including (i) ratios between blue shark catches and species-specific catches derived from ICCAT Task I data; (ii) catch/effort and standardised CPUE; and (iii) shark fin trade data. Figure 8.4 shows the catch series (1971–2013) for North Atlantic blue shark available for the 2015 stock assessment (SA2015), the 2008 stock assessment catches (SA2008), and the catch series obtained using shark-fin ratios (three different series, see for example Clarke *et al.*, 2006). Both stock assessment series followed a similar trend (but with large differences in some years) with catches oscillating several times between 15 000 t and 55 000 t. The three shark-fin series showed completely different trends (continuous upward trend) with catches starting around 10 000 t in the 1980s and growing to nearly 60 000 t in 2011 (Anon., 2015). Generally, the overall data for blue shark (and sharks in general) reported to ICCAT has improved over time (more complete series by species, lesser quantities of unclassified sharks, less weight of unclassified gears in the shark series, etc.). However, many unclassified shark species, mostly grouped by family (e.g. Lamnidae, Carcharhinidae, Sphyrnidae) and genera (e.g. *Rhizoprionodon, Carcharhinus, Sphyrna* and *Alopias* spp.) were reported to ICCAT in the past. The largest portion of unclassified sharks (1982–2013) is concentrated in longline and gillnet fisheries (Anon., 2015).

Japanese catches (landings and discards) from tuna longliners in the North Atlantic are estimated to have fluctuated between 1 400–2 400 t in 2006–2014, but a large increase to about 8 200 t is observed in 2015. These are higher than reported landings of the target species (bluefin tuna) from Japanese longliners in this period (ICCAT, 2008). Another study of Japanese bluefin tuna longline fisheries showed that the ratio of blue shark to the target species was about 1:1 (Boyd, 2008). Data from observations onboard a Chinese Taipei (Taiwanese) vessel targeting bluefin tuna in the southern North Atlantic showed that blue shark accounted for 76% of shark bycatch, though no information was presented on the percentage of blue shark in the total catch (Dai and Jang, 2008). Together, blue shark and shortfin mako account for between 69% and 72% of catches from Spanish and Portuguese surface longliners in the North Atlantic (Oceana, 2008).

The most recent ICCAT data publicly available for Task 1 data (landings and dead discards) for blue shark from the North Atlantic indicated a decrease in 2017–2019 (though 2019 data may be incomplete) compared to 2016 (Table 8.3). This would imply a reduction in landings in line with the ICCAT Recommendations relating to catch limits (see Section 8.2.3).

8.3.2 Discards

Historically, the relative low value of blue shark meant that it was not always retained for the market, with the fins the most valuable body part. In some fisheries the fins were retained and the carcasses discarded. In 2013, EU prohibited this practice (see Section 8.2.4).

Accurate estimates of discarding are required to quantify total removals from the stock. Currently no such estimates are available. Differences between estimated and reported catch in various fisheries (ICCAT, 2008 and references cited therein) suggest that discarding is widespread in fisheries taking blue shark.

Discard estimates are available for fisheries from Chinese Taipei, Korea Rep., USA, and UK (Bermuda) in recent years and from 2000 onwards from USA. However, they represent a limited part of total discards. The full extent of blue shark bycatch cannot be assessed using the data available, but evidence suggests that longline operations can catch more blue sharks than target species. There is considerable bycatch of blue sharks in Japanese and Taiwanese tuna longliners operating in the Atlantic. However, it is not possible, to estimate discard rates from these fleets from the information available. Discards can be assumed to be far higher than reported (Campana *et al*., 2005), especially in high seas fisheries.

Information on elasmobranchs discards in demersal otter trawl, deep-water set longlines, set gillnet and trammel net fisheries for ICES Division 9.a (2004–2013) showed that blue shark was caught infrequently and discarded in the longline fishery but not in the other fisheries (Prista *et al*., 2014).

8.3.3 Discard survival

Blue shark is one of the most frequent shark species captured in pelagic longline fisheries, and there are several estimates of survival (Boggs, 1992; Francis *et al*., 2001; Campana *et al*., 2005; Diez and Serafy, 2005). It is thought that most discards of whole sharks would be alive on return to the sea. For instance, discard survival rate is estimated to be about 60% in longline fisheries and 80% in rod and reel fisheries (Campana *et al*., 2005). More generally, the at-vessel mortality of longline-caught blue shark ranges from about 5–35% (summarised in Ellis *et al*., 2014 WD). Discard survival in such fisheries can be influenced by several factors, including hook type, soak time and size of shark. However, discarding can increase overall mortality attributable to fisheries: a study conducted on Canadian pelagic longliners targeting swordfish in the Northwest Atlantic (Campana *et al*., 2009) showed that "*overall blue shark bycatch mortality in the pelagic longline fishery was estimated at 35%, while the estimated discard mortality for sharks that were released alive was 19%. The annual blue shark catch in the North Atlantic was estimated at about 84 000 t, of which 57 000 t is discarded. A preliminary estimate of 20 000 t of annual dead discards for North Atlantic blue sharks is similar to that of the reported nominal catch, and could substantially change the perception of population health if incorporated into a population-level stock assessment*". The survival rate at hauling for blue shark was estimated to be 49% for the French pelagic longliners targeting swordfish in the southwest Indian Ocean. Field trials conducted with gears equipped with hook timers indicated that 29% were alive 8 h after their capture (Poisson *et al*., 2010). The survival rate of blue shark (at haul back) after a night-time soak may be lower than that during day-time soaks.

8.3.4 Quality of catch data

Catch data are incomplete, and the extent of finning in high seas fisheries is unclear. The historical use of generic shark categories is also problematic, although European countries now report more species-specific data.

In 2012, the ICCAT Secretariat noted some large discrepancies between the data in the EUROSTAT database and that of the ICCAT database, with EUROSTAT records showing captures almost double those of ICCAT in recent years.

Methods developed to identify shark species from fins (Sebastian *et al*., 2008; Holmes *et al*., 2009) could help to gather data on species targeted by illegal fishers, this information will greatly assist in management and conservation.

The variability of blue shark mortality estimates, relating to the proportion of live discards, hampers the estimation of total removals, although there are improving approaches to reporting of live discards to the ICCAT SCRS (Anon., 2015).

Given the uncertainty on the 2015 assessment of blue shark North Atlantic stock, ICCAT recommended continued monitoring of the fisheries by observer and port sampling programmes (ICCAT, 2015).

8.4 Commercial catch composition

No new information.

8.4.1 Conversion factors

Information on the length–weight relationship is available from several scientific studies (Table 8.4), as are the relationships between various length measurements (Table 8.5a and 8.5b). Campana *et al*., 2005 calculated the conversion relationships between dressed weight (W_D) and live weight or round weight (W_R) for NW Atlantic blue shark (n = 17) to be $W_R = 0.4 + 1.22\ W_D$ and $W_D = 0.2 + 0.81\ W_R$.

For French fisheries, the proportion of gutted fish to round weight is 75.19%. There is also a factor for landed round weight to live weight (96.15%), meaning that there is a 4% reduction in weight because of lost moisture (Hareide *et al*., 2007). Various estimates of fin weight to body weight are available (Mejuto and García-Cortés, 2004; Santos and Garcia, 2005; Hareide *et al*., 2007; Santana-Garcon *et al*., 2012; Biery and Pauly, 2012).

8.5 Commercial catch and effort data

For the North Atlantic stock, reported catches showed an increase in 1998, followed by a gradual decline until 2002 and then an increase (Figure 8.3). The CPUE input data available were comprehensively described and presented in the 2015 blue shark data preparatory meeting report (Anon., 2015). Following the work conducted for the 2008 SCRS blue shark stock assessment, CPUE were combined through a GLM with two choices of weighting: by the catch of the flag represented by each index and by the area of the flag represented by each index. Additionally, a hierarchical index of abundance that combines all available indices into a single series was also developed. However, it was noted that the process of combining CPUE indices was discouraged as they tend to mask the individual trends of the series and the underlying reasons as to why the series are different. It also indicated that some models can stochastically make use of the different series without need to combine these indices. It was suggested that it may be more useful to group CPUEs according to similar trends, and to include these as separate scenarios as was discussed during the 2015 bigeye tuna assessment.

Table 8.6 shows the various CPUE indices currently available (EU-Portugal, EU-Spain, USA, Japan, Chinese Taipei, and Venezuela), which have been considered for use in the assessment.

These CPUE indices show a relatively flat trend throughout the time-series, but with high variance (Tables 8.6–8.7; Figure 8.5).

8.6 Fishery-independent surveys

No fishery-independent data are available for the NE Atlantic, although such data exist for parts of the NW Atlantic (Hueter *et al*., 2008). A survey from 1977–1994 conducted by the US NMFS documented a decline among juvenile male blue sharks by 80%, but not among juvenile females, which also occur in fewer numbers in the area, the western North Atlantic off the coast of Massachusetts (Hueter *et al*., 2008). The authors concluded that vulnerability to overfishing in blue sharks is present despite their enhanced levels of fecundity relative to other carcharhinid sharks.

8.7 Life-history information

Blue shark has one of the widest ranges of all the shark species, being common in pelagic, oceanic waters in tropical and temperate oceans worldwide, as well as closer to shore (Coelho *et al*., 2018). Various papers have reviewed the biology of blue shark (Nakano & Seki, 2003; da Silva *et al*., 2021).

In a satellite telemetry study, Queiroz *et al.* (2010) described complex and diverse types of behaviour depending on water stratification and/or depth (Figure 8.6). Females tagged in the Western channel were able to spend up to 70 days in the shelf edge area in the Bay of Biscay; whereas tagged juveniles showed relatively extensive vertical movements away from the southern nursery areas. Results indicated that the species inhabited waters with a wide temperature range (10–20°C).

The US National Marine Fisheries Service also conducts a Cooperative Shark Tagging Programme (CSTP; Kohler *et al*., 1998; NMFS, 2006), with tagging in the NE Atlantic also being undertaken under the auspices of the Inshore Fisheries Ireland (formerly the Irish Central Fishing Board) Tagging Programme (Green, 2007 WD) and UK Shark Tagging Programme, and there have been other earlier European tagging studies (e.g. Stevens, 1976). The tag and release results presented by ICCAT (2012; Figure 8.7) highlights the large number of blue shark tagged to date, and the extensive horizontal movements undertaken by blue shark in the Atlantic.

In Australian waters, blue shark exhibits oscillatory dive behaviour between the surface layers to as deep as 560–1000 m. Blue sharks mainly occupied waters of 17.5–20.0°C and spent 35–58% of their time in <50 m depths and 10–16% of their time >300 m (Stevens *et al*., 2010). The distribution and movements of blue sharks are strongly influenced by seasonal variations in water temperature, reproductive condition and prey availability. Blue shark often occurs in large single-sex schools containing individuals of similar size.

Adult blue sharks have no known predators, although sub-adults and juveniles are eaten by shortfin mako, white shark and sea lions. Fishing is likely to be a major contributor to adult mortality. An estimation of fishing mortality rate via satellite tagged sharks being recaptured by fishing vessels ranged from 9–33% (Queiroz *et al*., 2010).

Various studies have compiled biological information on this species in the North Atlantic and other areas, with some of these data summarized in Tables 8.4 (length–weight relationships), 8.3a and 8.3b (length–length relationships), Table 8.8 (growth parameters) and Table 8.9 (other life-history parameters). Based on life-history information, the blue shark is considered to be among the most productive shark species (ICCAT, 2008).

New life history inputs were obtained from data first assembled at the ICCAT 2014 Intersessional Meeting of the Shark Species Group (SCRS/2014/012) and additional information provided during the 2015 blue shark data preparatory meeting (SCRS/2015/142). These included maximum population growth rates (rmax) and steepness (h) values of the Beverton–Holt stock–recruitment relationship for North and South Atlantic stocks of blue shark, based on the latest biological information available gathered at the 2015 blue shark data preparatory meeting. To encompass a plausible range of values, uncertainty in the estimates of life history inputs (reproductive age, lifespan, fecundity, von Bertalanffy growth parameters, and natural mortality) was incorporated through Monte Carlo simulation by assigning statistical distributions to those biological traits in a Leslie matrix approach. Estimated productivity was high (rmax = 0.31–0.44 y^{-1} for the North Atlantic stock), similar to other stocks of this species. Consequently, analytically derived values of steepness were also high (h = 0.73–0.93 for the North Atlantic stock).

The influence of different biological parameters (e.g. growth coefficients, reproductive periodicity, first maturation age, natural mortality and longevity) on estimated blue shark productivity was assessed. Age at first maturity and growth coefficients substantially influenced the estimated productivity (e.g. a low age at first maturity and high growth coefficient results in high productivity), and reproductive periodicity also affected productivity (i.e. a longer breeding period decreased productivity). Biological parameters should be carefully considered when they are used in the stock analysis, especially when estimated productivity is inconsistent with trends in abundance indices. The level of depletion experienced by blue shark stocks may affect the productivity or population growth through density dependence, and differences in environmental water temperature may also affect growth rates (Anon., 2015).

8.8 Exploratory assessment models

8.8.1 Previous assessments

In 2004, ICCAT completed a preliminary stock assessment (ICCAT, 2005). Although results suggested that the North Atlantic stock were above biomass in support of MSY, the assessment remained conditional on the assumptions made. These assumptions included (i) estimates of historical shark catch, (ii) the relationship between catch rates and abundance, (iii) the initial state of the stock in 1971, and (iv) various life-history parameters. It was pointed out that the data used for the assessment did not meet the requirements for proper assessment (ICCAT, 2006), and further research and better-resolved data collection was highly recommended.

In 2008, three models were used in stock assessment conducted by ICCAT (ICCAT, 2008 and references cited therein): a Bayesian surplus production model, an age-structured model that did not require catch data (catch-free model), and an age-structured production model. Results with the Bayesian surplus production model produced estimates of stock size well above MSY levels (1.5–2* B_{MSY}), and estimated F to be very low (at F_{MSY} or well below it). The carrying capacity of the stock was estimated so high that the increasing estimated catches (25–62 000 t over the time-series) generated very low F estimates. Sensitivity analyses showed that the stock size estimate was dependent on the weighting assigned to the Irish CPUE series. Equal weighting of this and the other series produced a stock size at around B_{MSY}. Other sensitivity analyses indicated similar results to the base case run, with the stock well above MSY levels.

The age-structured biomass model displayed different results with either a strong decrease in biomass throughout the series to about 30% of virgin levels, or a less pronounced decline. The prior for the virgin biomass assigned high values to a very small number of biomass values but also indicated that the range of plausible values of this parameter has a heavy tail. This is probably because there is not enough information in the data to update the model and thus provide a narrower range of plausible values and thus provide a more precise estimate of the biomass of the stock.

The age-structured model not requiring catch information estimated that F was higher than F_{MSY}, but still low and that the current SSB estimated at around 83% of virgin levels.

As a consequence of the results in 2008, ICCAT concluded that biomass was estimated to be above the level that would support MSY (ICCAT, 2008). These results agreed with earlier work (ICCAT, 2005). Stock status appeared to be close to unfished biomass levels and fishing mortality rates were well below those corresponding to the level at which MSY is reached. However, ICCAT (2008) pointed out that the results were heavily dependent on the underlying assumptions. In particular, the choice of catch data to be used, the weighting of CPUE series and various life-history parameters used as input in the model. ICCAT was unable to conduct sensitivity analyses of the input data and assumptions (ICCAT, 2008).

Owing to those weaknesses, no firm conclusions were drawn from the preliminary assessments conducted by ICCAT. ICCAT, 2008 stated that most models used predicted that this stock was not overfished but did not use these results to infer stock status and to provide management advice.

8.9 Stock assessment

The North Atlantic Blue shark stock was assessed by ICCAT in 2015 using two different approaches (see ICCAT, 2015 for more details): Bayesian Surplus Production Model (BSPM) and length-based age-structured models - Stock Synthesis (SS3).

The Bayesian Surplus Production Models adjusted consistently estimated a posterior distribution for *r* that was similar to the prior, and a posterior for *K* with a long right tail with high mean and CV (ICCAT, 2015). The estimated biomass trajectory stayed close to *K* for most runs, and the harvest rate estimate was low (Figure 8.8). The inclusion of a process error in the model did not improve the results. When each CPUE index was fitted separately, the posterior mean of *K* varied and the CVs were large, implying that none of the indices were particularly informative about the value of *K*.

Several SS3 runs were undertaken. Run 4 and 6 (see details below) which utilized multiplication factors to reduce the input sample size assigned to length composition data in the model likelihood resulted in reasonable convergence diagnostics (described below).

Model Run	Model Adjustments				
Preliminary Run 1	Natural weights used in model likelihood Length composition input sample size (n = observed) Abundance indices (inverse CV weighting; SCRS/2015/151)				
Preliminary Run 2 CV adjustment	Same as Preliminary Run 1 + Adjust CV of S9 (ESP-LL-N) Constant CV of 20% applied to S9 (ESP-LL-N)				
Preliminary Run 3 Sample size adjustments	Same as Preliminary Run 2 + Adjust input sample size for length comp Maximum length composition input sample size (n=200)				
Preliminary Run 4	Same as Preliminary Run 2 + Apply variance adjustment to length comp.				
Fleet	F1	F2	F3	F4	F5
Variance adjustments	0.01	0.01	0.1	0.1	0.1
Preliminary Run 5	Same as Preliminary Run 2 + Apply variance adjustment to length comp.				
Fleet	F1	F2	F3	F4	F5
Variance adjustments	0.0184	0.0478	0.0261	0.1373	0.2236
Preliminary Run 6	Same as Preliminary Run 2 + Apply variance adjustment to length comp.				
Fleet	F1	F2	F3	F4	F5
Variance adjustments	0.0019	0.0047	0.0046	0.0573	0.0403

Model fits to CPUE and length composition data were similar for both runs. The fitting to abundance tracked trends well and were within most annual 95% confidence intervals for many abundance indices, including S3 (JPLL-N-e), S4 (JPLL-N-l), S6 (US-Obs-cru), S7 (POR-LL), and S9 (ESP-LL-N) (Figures 8.9–8.10). Model fits tracked trends reasonably well for abundance index S2 (US-Obs), but were often outside annual 95% confidence intervals. Predicted abundance was flat for abundance indices S8 (VEN-LL) and S10 (CTP-LL-N), probably because of large 95% confidence intervals for S8 and high inter-annual fluctuations in the early years for S10. Indices S1 (US-Log) and S5 (IRL-Rec) were only included in the model for exploratory purposes, were not fit in the model likelihood (lambda = 0), and had no influence on model results or predicted values. Model fits to length composition were reasonable for aggregate data (Figure 8.11).

Both run 4 and run 6 resulted in sustainable spawning stock size and fishing mortality rates relative to maximum sustainable yield (Figures 8.12–8.14). However, run 6 (the model run with relatively less weight applied to the length composition data in the model likelihood) resulted in a relatively more depleted stock size, compared to run 4.

Both models suggested sustainable spawning stock size and fishing mortality rates relative to maximum sustainable yield. The model with a relatively lower sample size assigned to the length composition data resulted in a relatively more depleted stock size. However, model fits to length composition were insufficient for annual length composition data, for which a bimodal pattern was evident. This is related to spatial segregation of the population. It was suggested that more work should be done to improve the fits to length composition data before using the model to provide management advice.

8.10 Quality of assessments

At the 2015 ICCAT assessment meeting, considerable progress was made on the integration of new data sources (in particular size data) and modelling approaches (in particular model structure). Uncertainty in data inputs and model configuration was explored through sensitivity analyses, which revealed that results were sensitive to structural assumptions of the models. The production models showed a poor fit to the flat or increasing trends in the CPUE series combined with increasing catches. Overall, assessment results are uncertain (e.g. level of absolute abundance varied by an order of magnitude between models with different structures) and should be interpreted with caution.

For the North Atlantic stock, scenarios with the BSPM estimated that the stock was not overfished (B_{2013}/B_{MSY} = 1.50–1.96) and that overfishing was not occurring (F_{2013}/F_{MSY} = 0.04–0.50). Estimates obtained with SS3 varied more widely, but still predicted that the stock was not overfished (SSF_{2013}/SSF_{MSY} = 1.35–3.45) and that overfishing was not occurring (F_{2013}/F_{MSY} = 0.15–0.75). Comparison of results obtained in the assessment conducted in 2008 and the current assessment revealed that, despite significant differences between inputs and models used, stock status results did not change drastically (B_{2007}/B_{MSY} = 1.87–2.74 and F_{2007}/F_{MSY} = 0.13–0.17 for the 2008 base runs using the BSP and a catch-free age-structured production model).

8.11 Reference points

ICCAT uses F/F_{MSY} and B/B_{MSY} as reference points for stock status of this stock. These reference points are relative metrics rather than absolute values. The absolute values of B_{MSY} and F_{MSY} depend on model assumptions and results and are not presented by ICCAT for advisory purposes.

8.12 Conservation considerations

The global IUCN listing for blue shark is Near Threatened (Rigby *et al.*, 2019), and it has the same listing in European waters, although is listed as Critically Endangered in the Mediterranean Sea (https://www.iucnredlist.org).

Blue shark was listed on Appendix II of the Convention on the Conservation of Migratory Species of Wild Animals (CMS) in 2017. However, it was not subsequently listed on Annex 1 of the Sharks-MoU.

8.13 Management considerations

Based on the scenarios and models explored, ICCAT considered the status of the North Atlantic stock as unlikely to be overfished nor subject to overfishing. However, due to the level of uncertainty, no specific management recommendations have been developed until 2017. Since 2017 Recommendation 16–12 is in place which states: "*If the average total catch of the North Atlantic blue shark in any consecutive two years from 2017 onward exceeds the average level observed during the period 2011–2015 (i.e. 39 102 t), the Commission shall review the implementation and effectiveness of these measures. Based on the review and the results of the next stock assessment scheduled for 2021 or at an earlier stage if enough information is provided to SCRS, the Commission shall consider introduction of additional measures*".

A further update in 2019 in Recommendation 19-07 is a follows: "*If in any year the total catches of the North Atlantic blue shark exceed the TAC, the Commission shall review the implementation of these measures. Based on the review and the results of the next stock assessment scheduled for 2021 or at an earlier stage if enough information is provided to the SCRS, the Commission shall consider introduction of additional measures*." In this same Recommendation (19-07) catch limits for the EU, Japan and Morocco were set.

Catch data are highly unreliable. Some CPUE series exist, and where data are available, show a relatively flat trend throughout the time-series, but with high variance. Further work is required to explain the trends and to better quantify removals from the stock.

Catch data are considered incomplete, and underestimated. There have been unaccounted discards and a substantial occurrence of finning over parts of the time series. Data reported to ICES, ICCAT and FAO can vary.

For accurate stock assessments of pelagic sharks, better fishery data are required. In addition, reporting procedures must be strengthened so that all landings are reported, and that landings are reported to species level, rather than generic "shark nei" categories. In the absence of reliable landings and catch data, catch ratios and market information derived from observers can provide useful information for understanding blue shark fishery dynamics.

For the North Atlantic stock, smaller sized blue sharks have been observed to dominate north of 30ºN, while larger sized blue sharks dominated south of 30ºN. In order to be able to account for the differences in size composition of fish in different areas, future implementations of SS3 should consider this spatial structure in the fleets. This will require estimating fleet and area specific CPUE indices, catch and size distributions. Ideally the model could also be separated by sex.

Blue shark is considered to be one of the most productive sharks in the North Atlantic. As such, it can be expected to be more resilient to fishing pressure than other pelagic sharks. However, the high degree of susceptibility to longline fishing and the poor quality of the information available to assess the stock is a cause for concern. Given the uncertainty of the results and that this species is a significant bycatch, especially in tuna and billfish fisheries, there is a need for continued monitoring of the fisheries by observer and port sampling programmes. There are currently no fishery-independent data available for that part of the stock in the ICES area.

8.14 References

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Table 8.1. Blue shark in the North Atlantic. Landings (t) by country 1978–2018 from ICCAT Task I catch data (accessed June 2019). These are considered underestimates, especially prior to 1997.

Stock	Country	1978	1979	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
North Atlantic	Belize																					
	Brazil																					
	Canada								320	147	968	978	680	774	1277	1702	1260	1494	528	831	612	547
	Cape Verde																+					
	China P.R.																					
	Chinese Taipei																					
	EU.Denmark											2	2	1	1		1	2	3	1	1	
	EU.Spain																			24497	22504	21811
	EU.France	4	12		9	8	14	39	50	67	91	79	130	187	276	322	350	266	278	213	163	399
	EU.Ireland																					66
	EU.Netherlands																					
	EU.Portugal												1387	2257	1583	5726	4669	4722	4843	2630	2440	2227
	EU.UK												1				+	12			1	+
	FR.St Pierre et Miquelon																					
	Japan																1203	1145	618	489	340	357
	Mexico																	+				
	Panama																					9
	Senegal																					
	Trinidad & Tobago																					
	U.S.A.			204		605	107	341	1112	1400	776	751	829	1080	399	1816	601	641	987	391	447	317
	UK.Bermuda																	3	1	1	2	8

Stock	Country	1978	1979	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	Korea Rep.																					
	Namibia																					
	South Africa																					
	Uruguay																					
	Venezuela																					
N. Atlantic	**Total**	**4**	**12**	**204**	**9**	**613**	**121**	**380**	**1482**	**1614**	**1835**	**1810**	**3028**	**4299**	**3536**	**9566**	**8084**	**8285**	**7258**	**29053**	**26510**	**25741**
Mediterra-nean	EU.Cyprus																					
	EU.Spain																			146	59	20
	EU.France																					
	EU.Italy																					
	EU.Malta																1	1	1	+	+	+
	EU.Portugal																				2	
	Japan																5	7	1	1		
Mediterra-nean	**Total**	**+**	**+**	**+**	**+**	**+**	**+**	**+**	**+**	**+**	**+**	**+**	**+**	**+**	**+**	**+**	**5.581**	**8.376**	**1.768**	**147.95**	**60.856**	**20.445**
N.ATL AND MED TOTAL		**4**	**12**	**204**	**9**	**613**	**121**	**380**	**1482**	**1614**	**1835**	**1810**	**3028**	**4299**	**3536**	**9566**	**8090**	**8293**	**7260**	**29201**	**26571**	**25761**

Table 8.1. ***Cont*****. Blue shark in the North Atlantic. Landings (t) by country 1978–2018 from ICCAT Task I catch data (accessed June 2019). These are considered underestimates, especially prior to 1997.**

			2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
	ATN		28174	21709	20066	22951	21742	22359	23217	26927	30723	35198	37178	38084	36786	37202	39881	39502	42029
	ATS		12444	14043	12682	14967	14438	20642	20493	23487	23097	23459	27799	34926	26347	19545	29292	22172	23938
	MED		45	47	17	11	125	72	178	50	81	185	216	40	42	100	235	85	79
TOTAL			40664	35800	32765	37928	36305	43072	43888	50464	53901	58842	65193	73050	63174	56848	69408	62012	66273
Landings	ATN	Longline	27305	20699	19290	22880	21297	22167	23067	26810	30514	35031	36952	37777	36549	36882	39677	38777	41772
		Other surf.	732	905	708	70	380	126	104	63	80	63	59	100	109	74	205	725	257
	ATS	Longline	12444	14042	12678	14961	14339	20638	20434	23417	22708	23453	27785	34531	25878	19375	27457	21355	23309
		Other surf.	0	1	4	6	99	3	59	10	375	6	14	391	264	0	1835	818	629
	MED	Longline	44	47	17	10	43	71	83	48	81	18	50	40	41	68	190	84	78
		Other surf.	1	1	1	0	81	0	95	2	1	167	165	0	0	32	45	1	2
Discards	ATN	Longline	137	105	68	0	63	66	45	53	129	102	167	205	127	246	122	124	87
		Other surf.	0	0	0	0	1	0	0	0	1	1	1	2	1	0		+	0
	ATS	Longline	0	0	0	0	0	0	0	60	14	0	0	4	206	169	114	122	139
		Other surf.	0	0	0	0	0	0	0	0	0	0	0	0	0	0		6	0
Landings	ATN	Barbados																9	6
		Belize	0	0	0	0	0	0	0	0	0	114	461	1039	903	1216		4	6
		Brazil	7	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0
		Canada	624	1162	836	346	965	1134	977	843	0	0	0	0	1	0		0	0
		Cape Verde	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0
		China PR	0	185	104	148	0	0	0	367	109	88	53	109	98	327		1	27
		Chinese Taipei	165	59	0	171	206	240	588	292	110	73	99	148	94	121	81	220	266
		EU.Denmark	2	1	13	5	1	0	0	0	0	0	0	0	0	0		0	0
		EU.Spain	24112	17362	15666	15975	17314	15006	15464	17038	20788	24465	26094	27988	28666	28562	25202	30078	29019
		EU.France	395	207	221	57	106	120	99	167	119	84	122	115	31	216	129	259	352
		EU.Ireland	31	66	11	2	0	0	0	0	0	0	0	1	3	2	1	0	0

		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
	EU.Netherlands	0	0	0	0	0	0	0	0	0	1	0	0	0	0		0	0
	EU.Portugal	2081	2110	2265	5643	2025	4027	4338	5283	6167	6252	8261	6509	3768	3694	2913	3859	7819
	EU.UKi	12	9	6	4	6	5	3	6	6	96	8	10	8	10	10	12	17
	FR.St Pierre et Miquelon	0	0	0	0	0	0	0	0	0	1	0	0	0	0		0	0
	Japan	273	350	386	558	1035	1729	1434	1921	2531	2007	1763	1227	2437	1808	2034	4011	4239
	Korea Rep.	0	0	0	0	0	0	0	0	0	0	0	537	299	327		0	10
	Marocco																873	0
	Mexico	0	6	0	0	0	0	0	0	0	0	0	0	0	0		0	0
	Panama	0	0	0	0	0	0	254	892	613	1575	0	0	0	289		0	0
	Senegal	0	0	456	0	0	0	0	43	134	255	56	0	5	12		13	3
	St.Vincent and Grenadines																0	119
	Suriname	0	0	0	0	0	0	0	0	0	0	0	0	181	281		0	0
	Trinidad and Tobago	0	0	6	3	2	1	1	0	2	8	9	11	11	8		4	2
	U.S.A.	291	39	0	0	7	2	2	1	8	4	9	65	56	32		31	30
	UK.Bermuda	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0
	Venezuela	43	47	29	40	10	28	12	19	8	73	75	118	98	52		129	116
Discards ATN	Candada																0	0
	Chinese Taipei	0	0	0	0	0	0	0	0	0	0	0	0	21	14	9	5	16
	Korea Rep.	0	0	0	0	0	0	0	0	0	0	0	0	0	0		19	27
	U.S.A.	137	106	68	0	65	66	45	54	130	103	167	206	106	231		18	1
	UK.Bermuda	0	0	0	0	0	0	0	0	0	0	0	0	0	0		82	43

Table 8.2. Blue shark in the North Atlantic. Update for 2018 from SCRS (2019).

Component	Area	Fleet	2017	2018
Landings	ATN	Longline	38509	32654
		Other surf.	1033	1086
	ATS	Longline	27522	33546
		Other surf.	487	664
	MED	Longline	92	54
		Other surf.	13	4
Discards	ATN	Longline	133	112
		Other surf.	0	0
	ATS	Longline	218	99
		Other surf.	5	0
Landings	ATN	Barbados	7	4
		Belize	201	317
		Brazil	0	0
		Canada	0	0
		Cape Verde	0	0
		China PR	2	6
		Chinese Taipei		
		EU.Denmark	0	0
		EU.Spain	27316	21685
		EU.France	124	94
		EU.Ireland	0	0
		EU.Netherlands		0
		EU.Portugal	5664	5195
		EU.United Kingdom	11	6
		FR.St Pierre et Miquelon	0	0
		Japan	4460	4111
		Korea Rep.	103	92
		Marocco	1475	1644
		Mexico	0	0
		Panama	0	437
		Senegal	4	1
		St.Vincent and Grena-		0
		Suriname		-
		Trinidad and Tobago	2	0
		U.S.A.	24	19
		UK.Bermuda	0	0
		Venezuela	104	
Discards		Candada	32	71
		Chinese Taipei	34	31
		Korea Rep.	29	
		U.S.A.	38	11
		UK.Bermuda		
Total	ATN		39675	33853
	ATS		28232	34309
	MED		105	58
	Total		68011	68220

Table 8.3. Blue shark in the North Atlantic. ICCAT Task I catch data by area for North Atlantic blue shark (accessed 15 June 2021, based on ICCAT data from 18/12/2020; data relate to landings and dead discards). Areas are Azores (AZOR), Canary Islands (CANA), Cape Verde (CVER), Gulf of Mexico (GOFM), Madeira Islands (MDRA), Northeast Atlantic (NE), North Atlantic (NORT), Northwest Atlantic (NW), Northwest Central Atlantic (NWC) and West Tropical Atlantic (WTRO).

Year	AZOR	CANA	CVER	GOFM	MDRA	NE	NORT	NW	NWC	WTRO	Total
1997				1		15363	203	1132	12547	40	29285
1998						12410	246	1047	13051	10	26764
1999				1		11960	617	892	12654	48	26172
2000				1		11857	438	989	14844	44	28174
2001				9		10351	594	687	9440	47	21128
2002				0		9847	490	858	8835	35	20066
2003	639					9617	1208	359	11143	40	23006
2004	526					6423	1515	1020	12245	12	21741
2005	1485		205	0	8	6378	1969	1160	11125	28	22359
2006	1203		186		28	6459	2022	1376	11931	12	23218
2007	1305		259	0	12	6588	4189	1745	12810	20	26927
2008	981		374	0	33	8794	5219	784	14530	10	30725
2009	2051	1	544	0	11	13363		2058	17056	114	35199
2010	3221	47	971	0	34	12870		938	19029	128	37239
2011	1287	4	774	0	18	10749		2132	22939	189	38092
2012	293		281	1		13443		1863	20707	195	36783
2013	110			0	0	13816		1958	20850	353	37087
2014	26			1		14159		1052	21193	149	36579
2015	38			1		18436		318	20680	155	39627
2016	40			0	0	26260		9269	8366	131	44068
2017	15			3	0	22308		9876	7445	17	39664
2018	620			4		17993		8795	6576	6	33995
2019				0	0	15994		5872	5400	12	27279

Table 8.4. Blue shark in the North Atlantic. Length–weight relationships for blue shark from different populations. Lengths in cm, and weights in kg unless specified in equation. W_R = round weight; W_D = dressed weight.

L (cm) W (kg) relationship	Sex	n	Length range (cm)	Source
W_D = (8.04021 x 10–7) L_F ^ 3.23189	C	354	75–250 (L_F)	García-Cortés and Mejuto, 2002
W_R = (3.1841 x 10–6) L_F ^ 3.1313	C	4529		Castro, 1983
W_R = (3.92 x 10–6) LT ^ 3.41	Male	17		Stevens, 1975
W_R = (3.184 x 10–7) L_T ^ 3.20	Female	450		Stevens, 1975
W_R = (3.2 x 10–6) L_F ^ 3.128	C	720		Campana *et al.*, 2005
W_D = (1.7 x 10–6) L_F ^ 3.205	C	382		Campana *et al.*, 2005

Table 8.5(a). Blue shark in the North Atlantic. Length–length relationships for male, female blue shark and both sexes combined from the NE Atlantic and Straits of Gibraltar (Buencuerpo *et al.*, 1998). L_S = standard length; L_F = fork length; L_T = total length; L_{UC} = upper caudal lobe length.

Females	Males	Combined
L_F = 1.076 L_S + 1.862 (n = 1043)	L_F = 1.080 L_S + 1.552 (n = 1276)	L_F = 1.079 L_S + 1.668 (n = 2319)
L_T = 1.249 L_S + 7.476 (n = 1043)	L_T = 1.272 L_S + 4.466 (n = 1272)	L_T = 1.262 L_S + 5.746 (n = 2315)
L_{UC} = 0.219 L_S + 4.861 (n = 1038)	L_{UC} = 0.316 L_S + 2.191 (n = 1264)	L_{UC} = 0.306 L_S + 3.288 (n = 2302)
L_T = 1.158 L_F + 5.678 (n = 1043)	L_T = 1.117 L_F + 2.958 (n = 1272)	L_T = 1.167 L_F + 4.133 (n = 2315)

Table 8.5(b). Blue shark in the North Atlantic. Length–length relationships for both sexes combined of blue shark from various populations and sources.

Stock	Relationship	n	Source
NW Atlantic	L_F = (0.8313) L_T + 1.3908	572	Kohler *et al.*, 1995
NE Atlantic	L_F = 0.8203 L_T –1.061		Castro and Mejuto, 1995
NW Atlantic	L_F = –1.2 +0.842 L_T	792	Campana *et al.*, 2005
NW Atlantic	L_T = 3.8 + 1.17 L_F	792	Campana *et al.*, 2005
NW Atlantic	L_{CF} = 2.1 + 1.0 L_{SF}	782	Campana *et al.*, 2005
NW Atlantic	L_{SF} = –0.8 + 0.98 L_{CF}	782	Campana *et al.*, 2005
NW Atlantic	L_F = 23.4 + 3.50 L_{ID}	894	Campana *et al.*, 2005
NW Atlantic	L_{ID} = –4.3 + 0.273 L_F	894	Campana *et al.*, 2005

Table 8.6. Blue shark in the North Atlantic. Indices of abundance for North and South Atlantic blue shark stocks. Source: ICCAT (2015).

			North Atlantic					
Year	Usobs	JPLLe	JPLLI	USOLD	PORLL	VENLL	ESPLL	CHTPLL
1957				0.98				
1958				0.48				
1959				1.11				
1960				1.18				
1961				1.13				
1962				1.5				
1963				0.7				
1964				0.87				
1965				1.55				
1966				1.27				
1967				1.43				
1968				1.31				
1969				1.96				
1970				0.97				
1971		0.87		1.08				
1972		1.46		1.93				
1973		1.12						
1974		2.62						
1975		1.85		0.88				
1976		1.07		0.75				
1977		1.89		1.82				
1978		1.58		1.06				
1979		1.3		0.860				
1980		2.21		0.830				
1981		2.19		1.050				
1982		2.08		0.780				
1983		1.81		1.010				
1984		1.22		0.680				
1985		1.51		0.740				
1986		1.52		0.480				
1987		2.13		0.500				
1988		1.21		0.440				
1989		1.51		0.800				
1990		1.34		0.940				
1991		1.26		1.220				
1992	7.455	1.9		0.63				
1993	11.076	2.43		0.95				
1994	9.717		2.33	0.98		0.047		
1995	10.17		2.1	0.73		0.073		
1996	8.208		2.05	0.47		0.017		
1997	14.439		2.05	1.25	158.14	0.154	156.83	
1998	18.408		1.72	1.16	169.02	0.216	154.45	
1999	6.663		1.89	0.76	149.83	0.117	179.91	
2000	9.541		1.58	0.78	201.44	0.151	213.05	
2001	2.306		1.71		222.14	0.133	215.63	
2002	2.277		1.37		200.86	0.074	183.94	
2003	1.876		1.97		238.77	0.044	222.88	
2004	9.503		1.79		266.16	0.034	177.27	0.749
2005	3.193		1.9		218.55	0.006	166.82	2.195
2006	4.674		2.16		212.63	0.013	177.11	1.308
2007	9.645		2.18		241.32	0.060	187.06	0.561
2008	8.512		2.48		225.68	0.088	215.80	0.495
2009	8.322		2.46		228.30	0.045	196.08	0.570
2010	13.545		2.45		276.76	0.040	209.03	0.877
2011	21.806		2.37		233.29	0.044	221.13	0.765
2012	8.128		2.6		305.53	0.107	238.00	0.668
2013	7.374		2.09		304.08	0.044	203.49	1.045

Table 8.7. Blue shark in the North Atlantic. Coefficients of variation (CVs) for North and South Atlantic blue shark stocks. Source: ICCAT (2015).

			North Atlantic					
Year	Usobs	JPLLe	JPLLl	USOLD	PORLL	VENLL	ESPLL	CHTPLL
1957				0.17				
1958				0.16				
1959				0.25				
1960				0.38				
1961				0.35				
1962				0.27				
1963				0.25				
1964				0.17				
1965				0.17				
1966				0.23				
1967				0.21				
1968				0.21				
1969				0.22				
1970				0.32				
1971		0.53		0.23				
1972		0.39		0.21				
1973		0.45						
1974		0.32						
1975		0.34		0.19				
1976		0.47		0.29				
1977		0.27		0.2				
1978		0.32		0.11				
1979		0.24		0.11				
1980		0.29		0.09				
1981		0.36		0.09				
1982		0.36		0.09				
1983		0.37		0.1				
1984		0.50		0.1				
1985		0.44		0.1				
1986		0.39		0.09				
1987		0.35		0.1				
1988		0.49		0.12				
1989		0.44		0.39				
1990		0.49		0.17				
1991		0.47		0.11				
1992	0.31	0.43		0.1				
1993	0.29	0.40		0.09				
1994	0.29		0.50	0.1		1.08		
1995	0.29		0.55	0.1		0.87		
1996	0.50		0.51	0.3		1.90		
1997	0.33		0.52	0.13	0.084	`	0.008	
1998	0.35		0.53	0.15	0.076	0.67	0.008	
1999	0.34		0.49	0.13	0.077	0.84	0.008	
2000	0.32		0.28	0.12	0.083	0.74	0.008	
2001	0.39		0.56		0.089	0.77	0.008	
2002	0.39		0.62		0.086	1.03	0.008	
2003	0.37		0.59		0.082	1.26	0.009	
2004	0.30		0.69		0.084	1.53	0.009	0.12
2005	0.35		0.71		0.087	3.88	0.010	0.19
2006	0.31		0.69		0.084	2.24	0.010	0.06
2007	0.32		0.61		0.085	1.35	0.011	0.22
2008	0.32		0.69		0.085	1.16	0.011	0.28
2009	0.31		0.64		0.086	1.56	0.012	0.17
2010	0.31		0.64		0.089	1.54	0.010	0.10
2011	0.29		0.51		0.079	1.51	0.010	0.12
2012	0.34		0.51		0.081	1.00	0.010	0.11
2013	0.31		0.21		0.085	1.84	0.011	0.14

Table 8.8. Blue shark in the North Atlantic. Von Bertalanffy growth parameters (L∞ in cm (L_T), k in years^{-1}, t0 in years) from published studies.

Area	L∞	k	t0	Sex	Study
North Atlantic	394	0.133	–0.801	Combined	Aasen, 1966
North Atlantic	423	0,11	–1.035	Combined	Stevens, 1975
NW Atlantic	343	0.16	–0.89	Males	Skomal, 1990
NW Atlantic	375	0.15	–0.87	Females	Skomal, 1990
NE Atlantic	377	0.12	–1.33	Combined	Henderson *et al.*, 2001
North Atlantic	282	0.18	–1.35	Males	Skomal and Natanson, 2002
North Atlantic	310	0.13	–177	Females	Skomal and Natanson, 2002
North Atlantic	287	0.17	–1.43	Combined	Skomal and Natanson, 2003
NW Atlantic	300	0.68	–0.25	Combined	MacNeil and Campana, 2002 (whole ages)
NW Atlantic	302	0.58	–0.24	Combined	MacNeil and Campana, 2002 (section ages)

Table 8.9. Blue shark in the North Atlantic. Biological parameters for blue shark.

Parameter	Values	Sample Size	Area	Reference
Reproduction	Placental viviparity			various
Litter size	25–50 (30 average)			various
Size-at-birth	30–50 cm LT			Various
Sex ratio (males: females)	1.5:1		NE Atlantic	García-Cortés and Mejuto, 2002
	1:1.44		NE Atlantic	Henderson *et al.*, 2001
	1.33:1		NW Atlantic	Kohler *et al.*, 2002
	1:2.13		NE Atlantic	Kohler *et al.*, 2002
	1:1.07	801	NE Atlantic (N. coast Spain)	Mejuto and García-Cortés, 2005
	1:0.9	158	NE Atlantic (S. coast Spain)	
	1:0.38	2187	N central Atlantic	
	1:0.53	4550	NW Atlantic	
Gestation period	9–12 months			Campana *et al.*, 2002
% of females revealing fecundation signs	0.74	415	NE Atlantic (N. coast Spain)	Mejuto and García-Cortés, 2005
	0	76	NE Atlantic (S. coast Spain)	
	36.27	601	N central Atlantic	
	18.15	1573	NW Atlantic	
% of pregnant females	0	415	NE Atlantic (N. coast Spain)	Mejuto and García-Cortés, 2005
	0	76	NE Atlantic (S. coast Spain)	
	14.6	601	N central Atlantic	
	9.8	1573	NW Atlantic	

Parameter	Values	Sample Size	Area	Reference
Male age-at-maturity (years)	4–6			various
Female age-at-maturity (years)	5–7			various
Male length-at-maturity	180–280 cm (LF)		NW Atlantic	Campana *et al.*, 2002
	190–195 cm (LF)			Francis and Duffy, 2005
	201 cm (LF; 50% maturity)		NW Atlantic	Campana *et al.*, 2005
Female length-at-maturity	220–320 cm (LF)			Campana *et al.*, 2002
	170–190 cm (LF)			Francis and Duffy, 2005
	> 185 cm (LF)			Pratt, 1979
Longevity (years)	16–20			Skomal and Natanson, 2003
Natural mortality (M)	0.23		Worldwide	Campana *et al.*, 2005 (mean of various studies)
Productivity (R2m) estimate: intrinsic rebound	0.061 (assuming no fecundity increase)		Pacific	Smith *et al.*, 1998
Potential rate of increase per year	43% (unfished)		NW Atlantic	Campana *et al.*, 2005
Population doubling time TD (years)	11.4 (assuming no fecundity increase)		Pacific	Smith *et al.*, 1998
Trophic level	4.1	14		Cortés, 1999

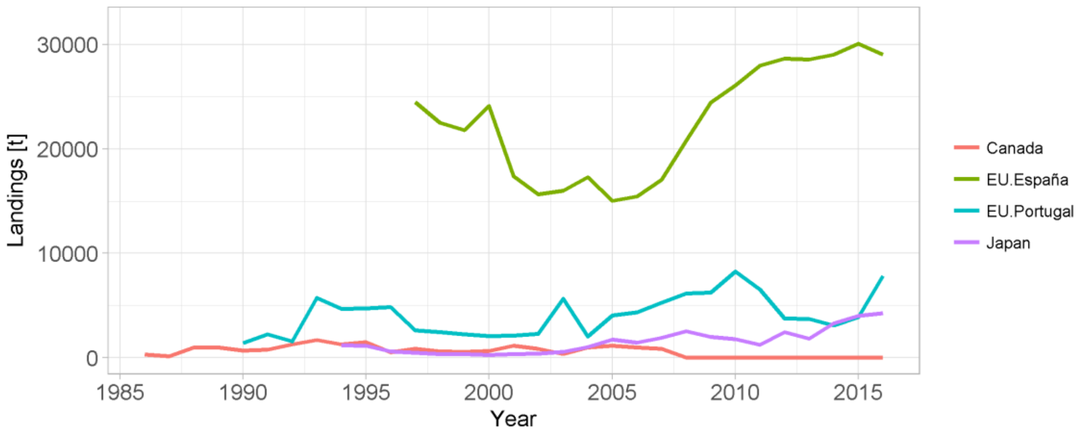


Figure 8.1. Blue shark in the North Atlantic. Preliminary estimates of landings of blue shark in the Atlantic for the four main countries (Source: ICCAT Task I data, Accessed June 2018).

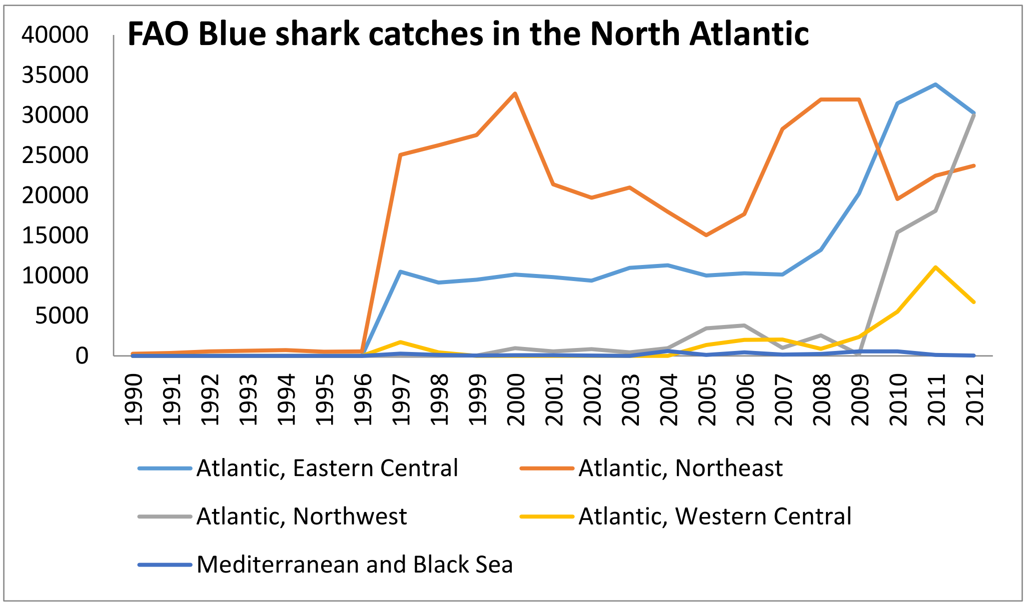


Figure 8.2. Blue shark in the North Atlantic. Preliminary estimates of landings of blue shark in the Atlantic Ocean for the different areas (Source: FAO, 2014).

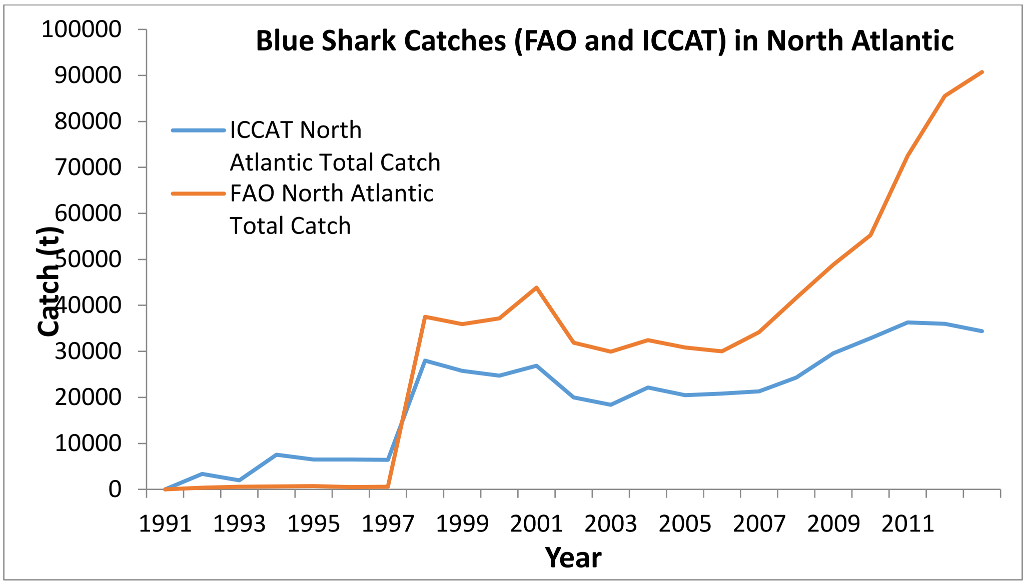
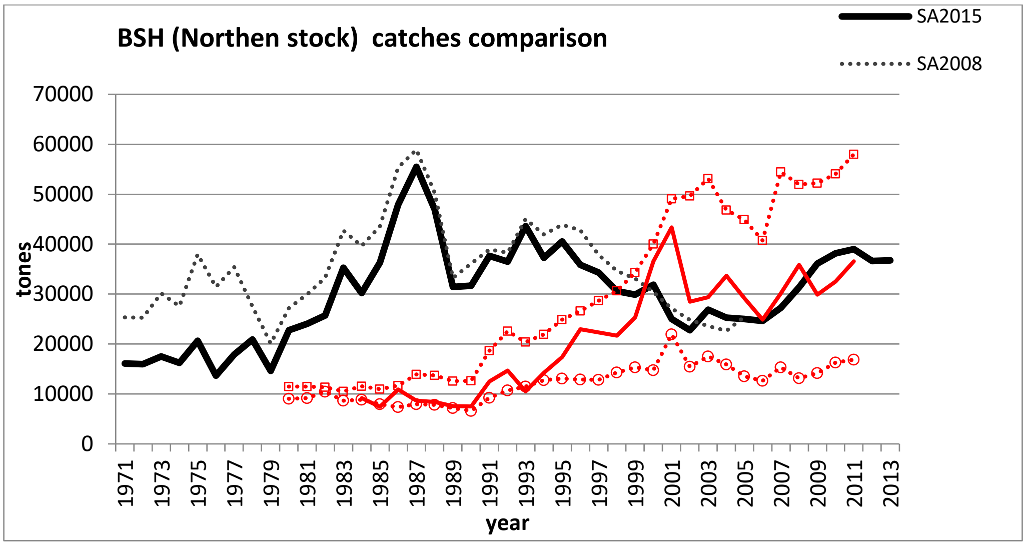


Figure 8.3. Blue shark in the North Atlantic. Blue shark catches in the North Atlantic from FAO and ICCAT data (1990–2013) illustrating the difference between data sources.



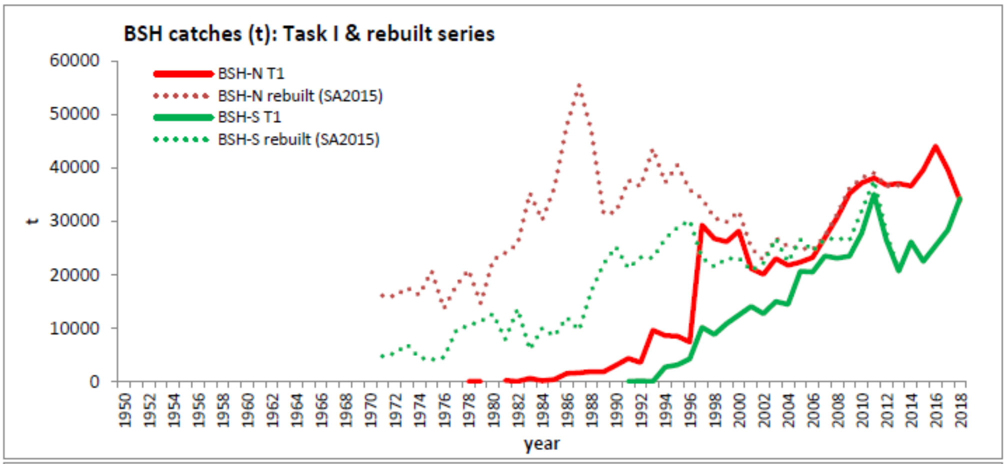


Figure 8.4. Top. Blue shark in the North Atlantic. Comparison of various catch series for the North Atlantic stock of blue shark (1971–2013). In black, the stock assessment catches from the 2008 stock assessment (dotted line) and 2015 estimations (solid line). In red, three catch series obtained using shark-fin ratios with three different approaches (area, effort, target level). Bottom: Update of catches reported to ICCAT (Task I) and estimated by SCRS (SCRS, 2019). Dotted lines are values from the 2008 assessment, solid line those of the 2015 estimates.

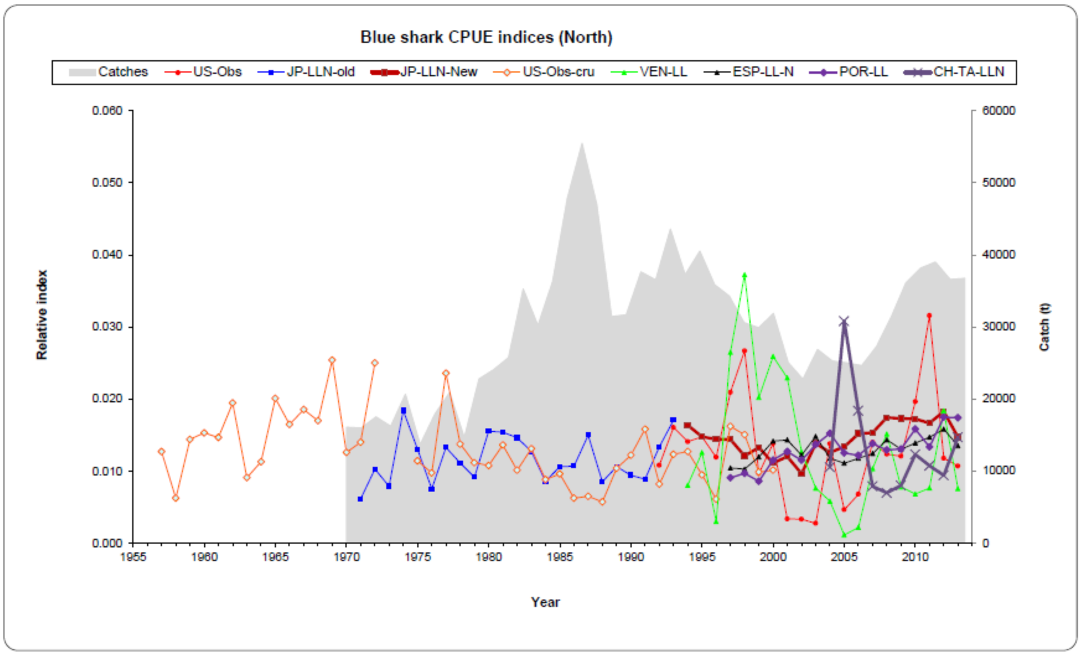


Figure 8.5. Blue shark in the North Atlantic. Indices of abundance and catches. Source: ICCAT (2019).

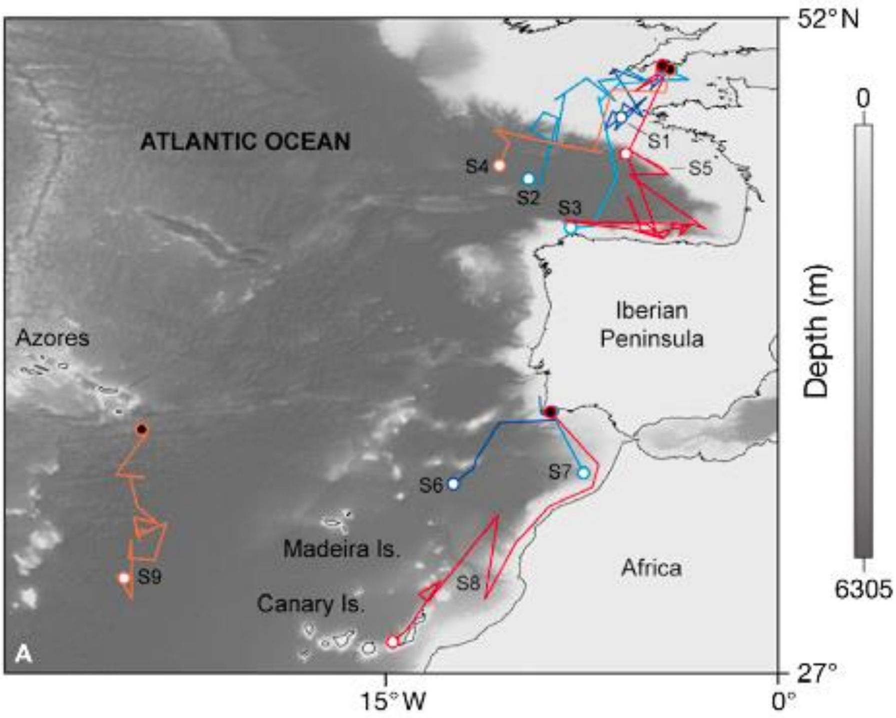


Figure 8.6. Blue shark in the North Atlantic. Pop-off satellite-tagged blue shark movement patterns. (A) General movements overlaid on bathymetry; black circles denote tagging locations and white circles the pop-up/capture locations. (B to J) Individual tracks overlaid on sea surface temperature maps; white circles are geolocated positions with date. Source: Queiroz *et al.* (2010).

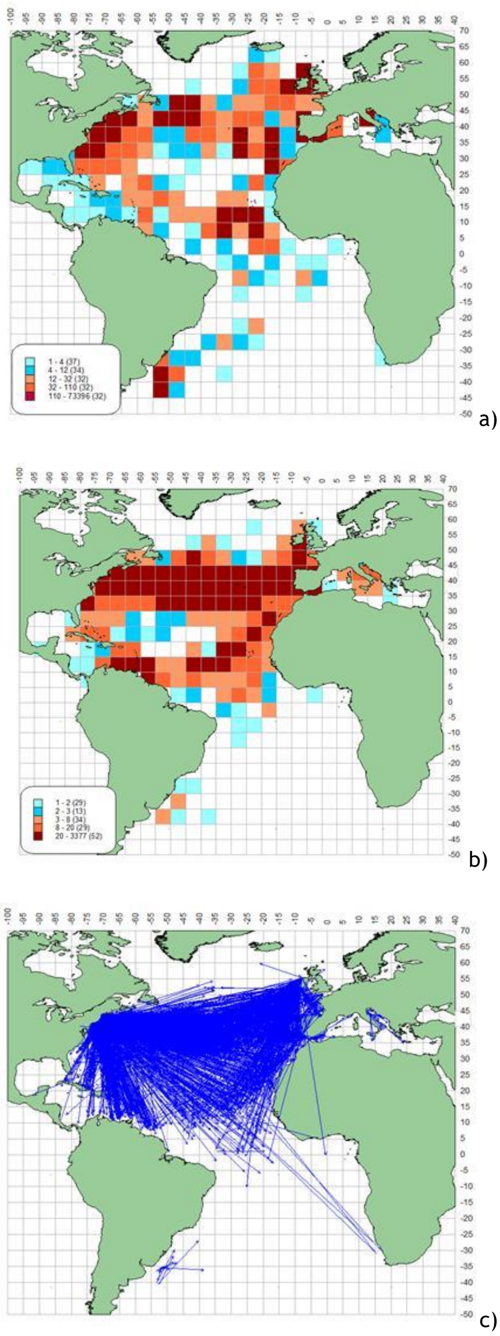


Figure 8.7. Blue shark in the North Atlantic. Blue shark tagging maps, presented by ICCAT (2012), showing (a) density of releases, (b) density of recoveries, and (c) straight line displacement between release and recovery locations.

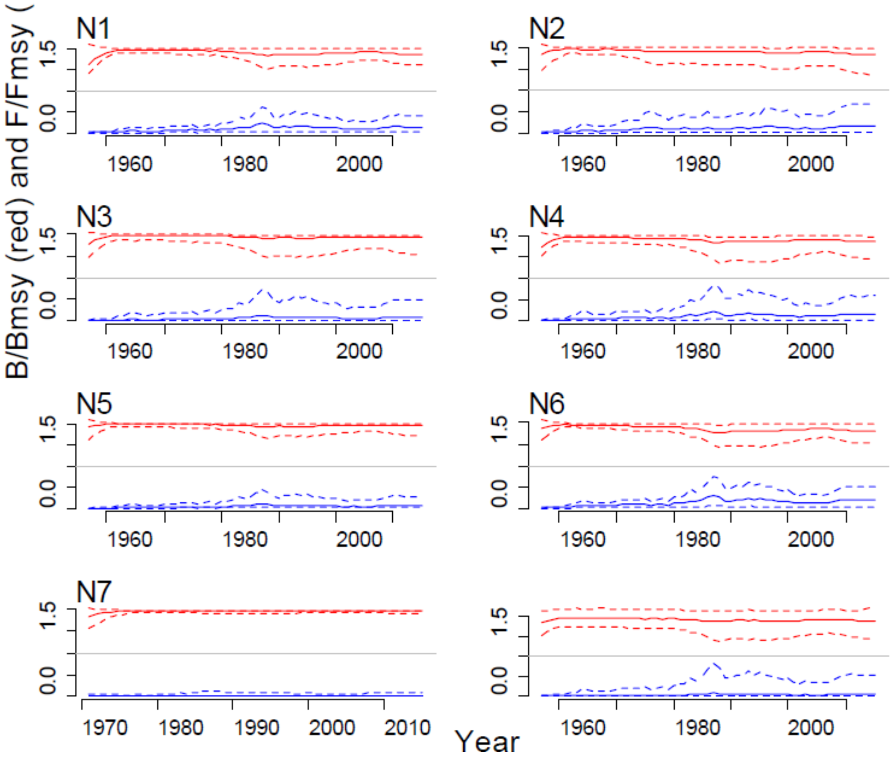


Figure 8.8. Blue shark in the North Atlantic. Estimated biomass relative to B_{MSY} (in red) and harvest rate relative to the MSY level (blue), for the BSP runs. Source: ICCAT (2015).

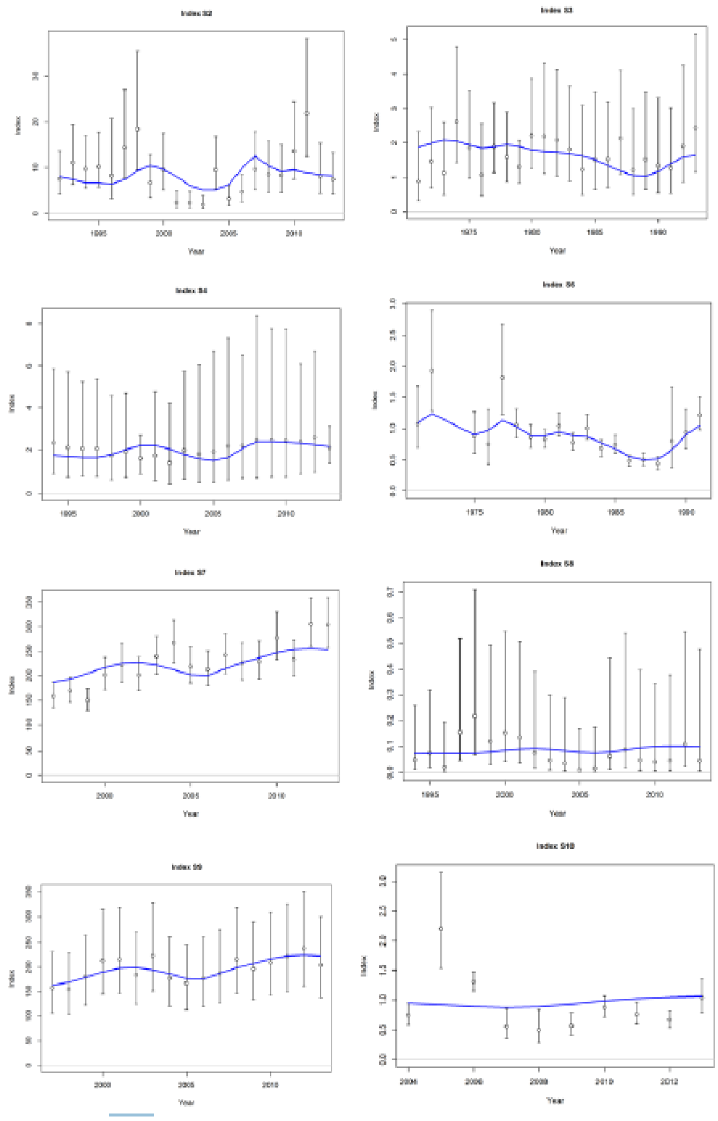


Figure 8.9. Blue shark in the North Atlantic. Preliminary Run 4 observed CPUE (open circles ± 95% confidence intervals assuming lognormal error) and model predicted CPUE (blue line) for abundance indices fit in the model likelihood: S2 (US-Obs, upper left), S3 (JPLL-N-e, upper right), S4 (JPLL-N-l, middle left), S6 (US-Obs-cru, middle right), S7 (POR-LL, middle left), S8 (VEN-LL, middle right), S9 (ESP-LL-N, lower left), and S10 (CTP-LL-N, lower right). Source: ICCAT (2015).

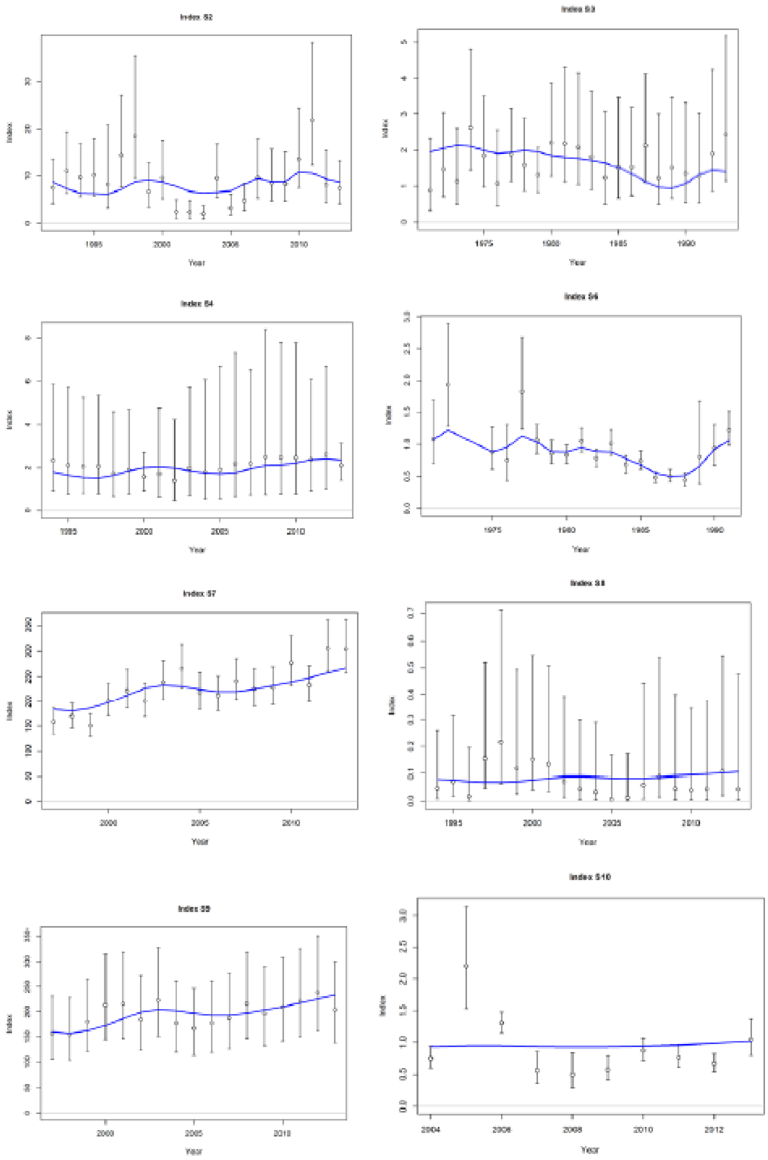
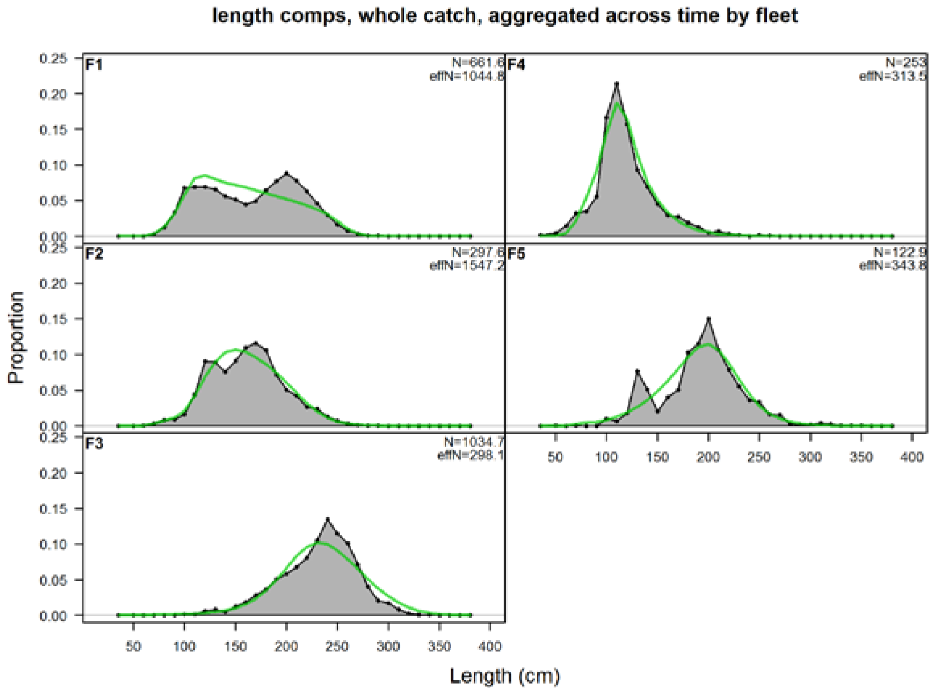


Figure 8.10. Blue shark in the North Atlantic. Preliminary Run 6 observed CPUE (open circles ± 95% confidence intervals assuming lognormal error) and model predicted CPUE (blue line) for abundance indices fit in the model likelihood: S2 (US-Obs, upper left), S3 (JPLL-N-e, upper right), S4 (JPLL-N-l, middle left), S6 (US-Obs-cru, middle right), S7 (POR-LL, middle left), S8 (VEN-LL, middle right), S9 (ESP-LL-N, lower left), and S10 (CTP-LL-N, lower right). Source: ICCAT (2015).



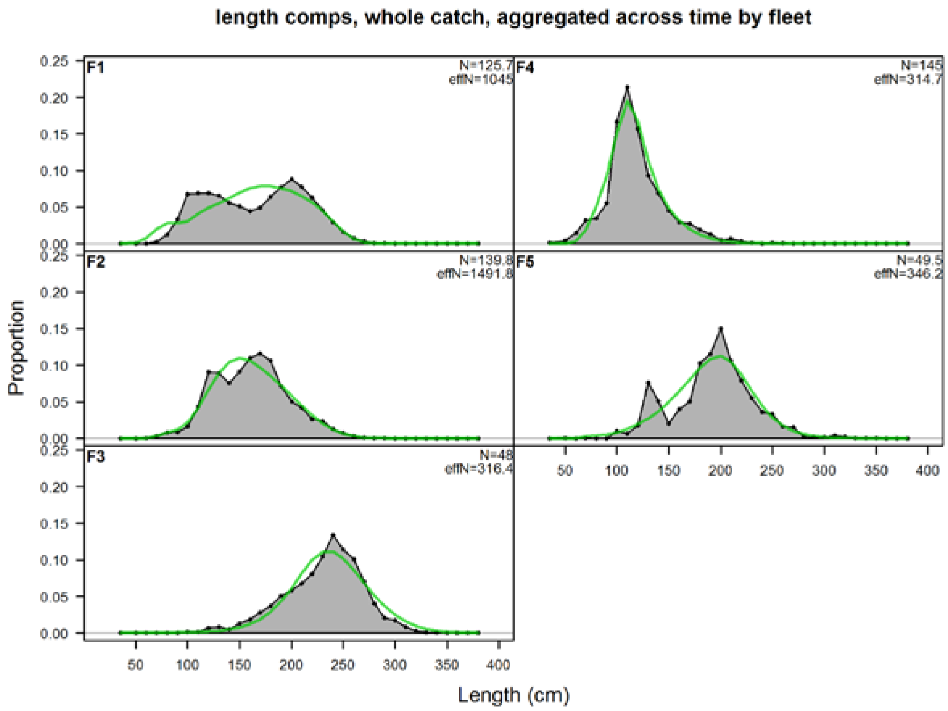


Figure 8.11. Blue shark in the North Atlantic. Model predicted (line) and observed (shaded) aggregated annual length compositions (female + male) for Preliminary Run 4 (upper panel) and Preliminary Run 6 (lower panel). Source: ICCAT (2015).

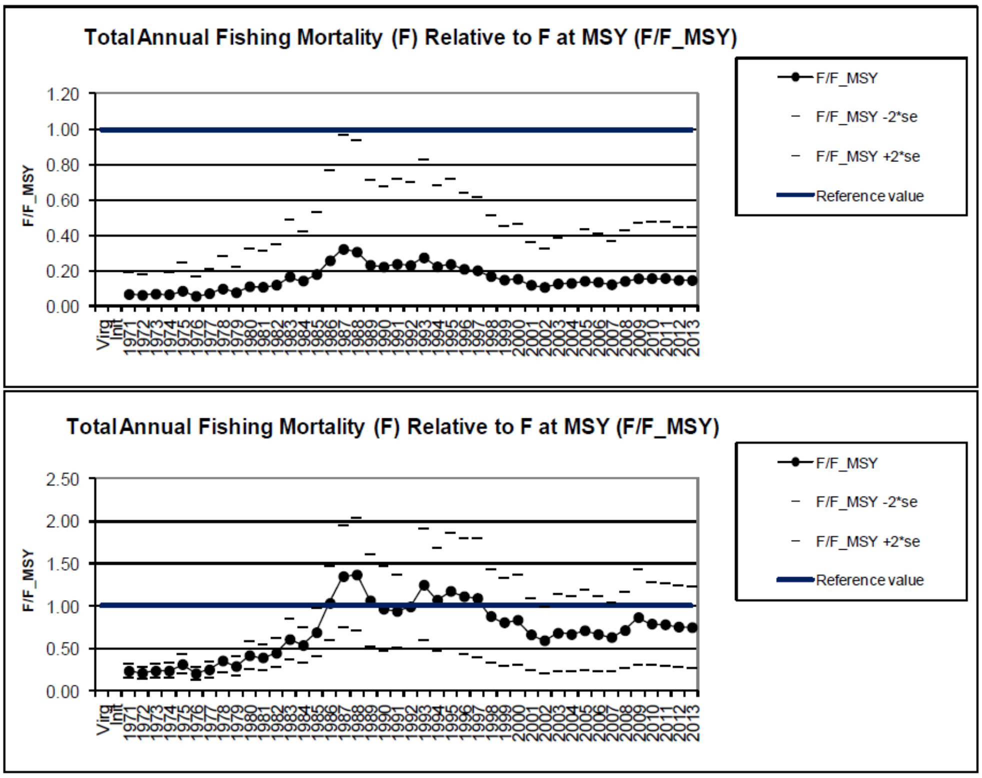


Figure 8.12. Blue shark in the North Atlantic. Estimated annual total exploitation rate in numbers (total fishing mortality for all fleets combined) relative to fishing mortality at MSY (F/F_{MSY}), obtained from Stock Synthesis output for Preliminary Run 4 (upper panel) and Preliminary Run 6 (lower panel). Source: ICCAT (2015).

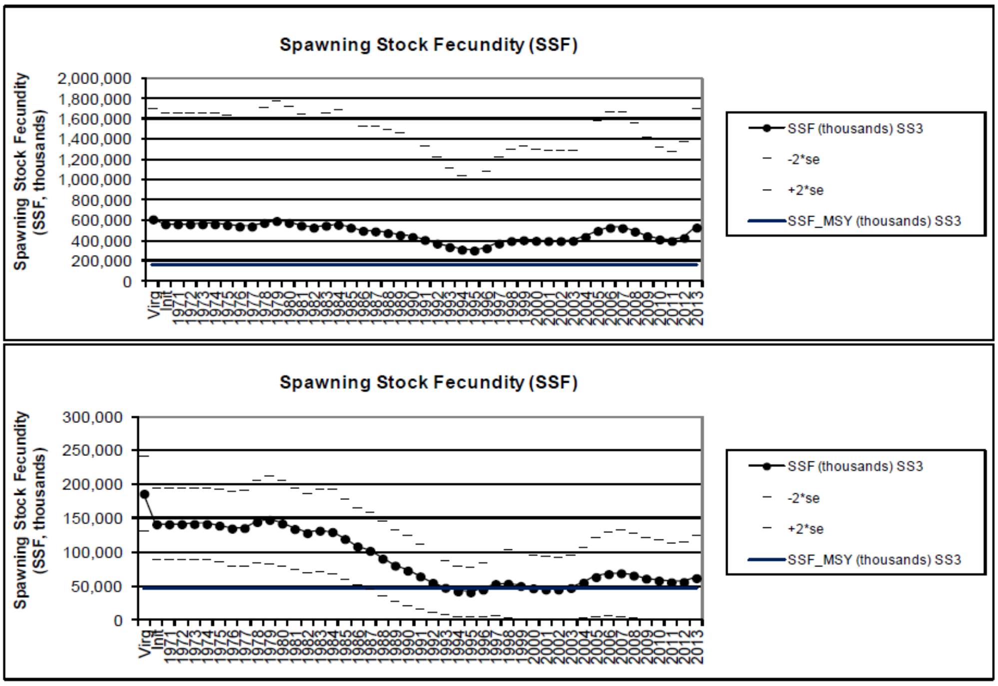


Figure 8.13. Blue shark in the North Atlantic. Estimated spawning stock size (spawning stock fecundity, SSF) along with approximate 95% asymptotic standard errors (±2*s.e.) relative to spawning stock size at MSY (SSFMSY) for Preliminary Run 4 (upper panel) and Preliminary Run 6 (lower panel). Source: ICCAT (2015).

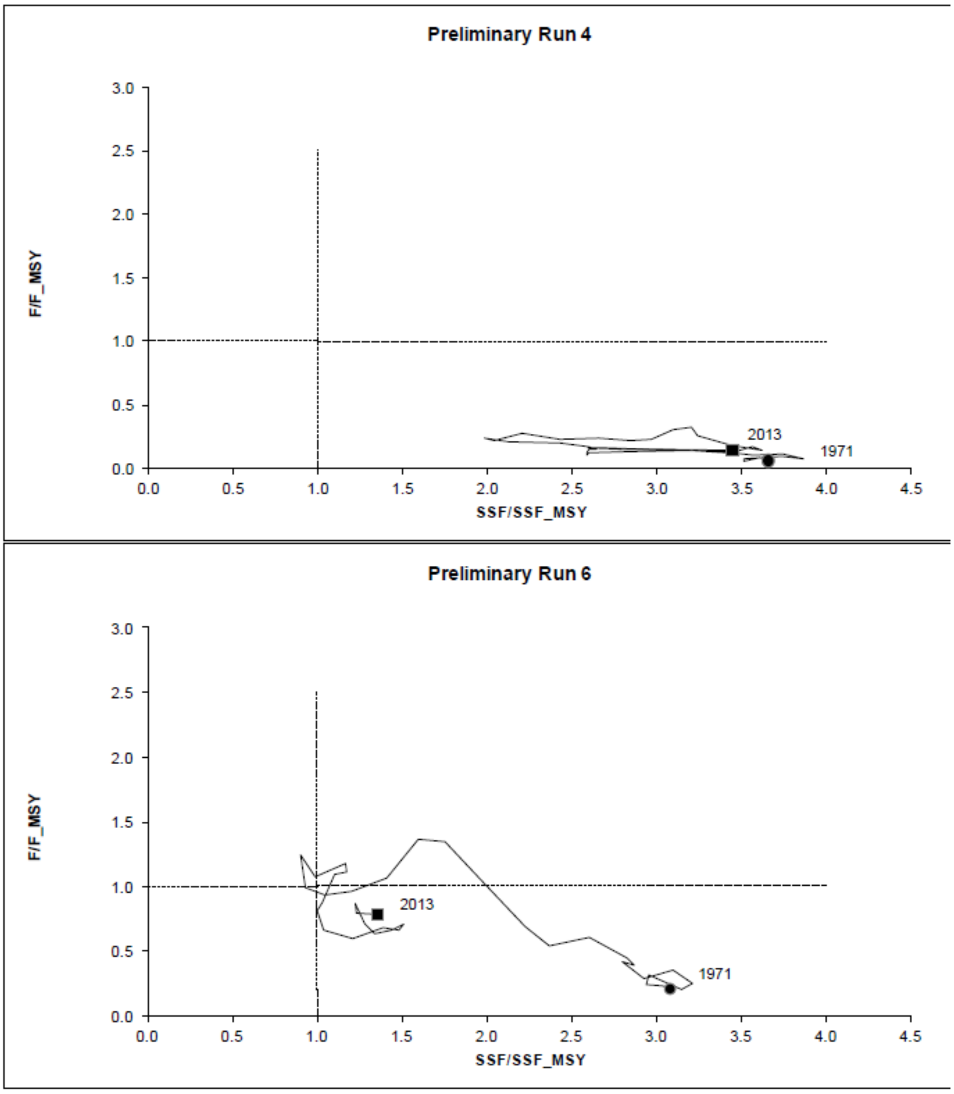


Figure 8.14. Blue shark in the North Atlantic. Kobe Phase plots for Preliminary Run 4 (upper panel) and Preliminary Run 6 (lower panel). The circle indicates the position of the start year of the model (1971) and the square represents the end year of the model (2013). The horizontal (dotted) line identifies the fishing mortality reference at maximum sustainable yield (F_{MSY}). The vertical (dotted) line identifies the reference spawning stock fecundity at maximum sustainable yield (SSF_{MSY}). Source: ICCAT (2015).

9 Shortfin mako in the North Atlantic (North of 5°N)

Shortfin mako sharks *Isurus oxyrinchus* Rafinesque are large, highly mobile, pelagic predators that inhabit tropical and temperate waters circumglobally and are prized in both recreational and commercial fisheries (Campana, Marks and Joyce, 2005).

The North Atlantic shortfin mako stock is assessed by the International Commission for the Conservation of Atlantic Tunas (ICCAT). ICCAT conducted a stock assessment for shortfin mako in 2017 (12–16 June). At the previous Data Preparatory meeting, the catch, effort and size data, as well as the tagging data were reviewed and the models to be used during the assessment and their assumptions were discussed.

9.1 Stock distribution

One stock of shortfin mako has been considered to exist in the North Atlantic (e.g. Kohler *et al.*, 2002) as genetic studies found no evidence to separate east and west populations in the Atlantic, but indicate differences between the North Atlantic and the South Atlantic and other oceans (Heist *et al*., 1996; Schrey and Heist, 2002). The relationship between shortfin mako in the North Atlantic and Mediterranean Sea is unclear, and so the North Atlantic stock assessment does not include data from the Mediterranean Sea.

Based on the oceanography of equatorial waters, and that other large pelagic species (e.g. swordfish, blue shark) have a southern stock boundary of 5°N, this latitudinal extent is used as the southern boundary of the North Atlantic shortfin mako stock. The stock area broadly equates with FAO Areas 27, 21, 31 and 34 (in part).

Preliminary results indicate that there is stock mixing, with males moving more between regions while the females seem to show philopatric behaviour (ICCAT, 2016). These population differences may imply different biological parameters between regions. Thus, the study of the biology of the species and further genetic studies are required for the clarification of stock boundaries (ICCAT, 2016).

9.2 The fishery

9.2.1 History of the fishery

Shortfin mako is a highly migratory species that is a frequent bycatch in pelagic longline fisheries targeting tuna and billfish, and in other high seas tuna fisheries. Like porbeagle, it is a relatively high-value species (cf. blue shark, which is of lower commercial value), being normally retained (Campana *et al*., 2005). Recreational fisheries on both sides of the North Atlantic also catch this species, with relatively large quantities reported from sport (rod and reel) fisheries reported to ICCAT (178 t in 2011). Some specimens are released alive from these fisheries.

Shortfin mako is also taken in Mediterranean Sea fisheries (STECF, 2003). For example, Tudela *et al*. (2005) observed 542 shortfin mako taken as bycatch in 4140 km of driftnets set in the Alboran Sea between December 2002 and September 2003.

Shortfin mako is an important shark species captured in pelagic longline fisheries targeting tunas and swordfish. As part of an on-going cooperative program for fisheries and biological data collection, information collected by fishery observers and scientific projects from several fishing nations in the Atlantic (EU-Portugal, Uruguay, Chinese Taipei, USA, Japan, Brazil and Venezuela) were analysed at the 2017 ICCAT shortfin mako data preparatory meeting (ICCAT, 2017).

9.2.2 The fishery in 2020

Reported landings of North Atlantic shortfin mako decreased in 2019–2020, in comparison to preceding years, which may relate to the introduction of more conservative management recommendations from ICCAT (ICCAT Recommendation 19-06).

9.2.3 Advice applicable

ICES does not provide advice for this stock. Assessment of this stock is considered to be the responsibility of ICCAT, who coordinate Recommendations to Contracting Parties, and Cooperating non-Contracting Parties, Entities or Fishing Entities (referred to as CPCs).

ICCAT Recommendation 14-06 on "shortfin mako caught in association with ICCAT fisheries" states that CPCs shall improve their reporting systems for the provision of Task I and Task II catch, effort and size data for shortfin mako. CPCs should also report to ICCAT information on the domestic actions taken to "*monitor catches and to conserve and manage shortfin mako sharks*".

ICCAT Recommendation 19-06 on "the conservation of North Atlantic stock of shortfin mako caught in association with ICCAT fisheries" requires CPC vessels flying their flag to promptly release North Atlantic shortfin mako, albeit with a range of derogations for the retention of dead bycatch (with appropriate observer coverage of electronic monitoring) or where size restrictions apply.

9.2.4 Management applicable

EC Regulation No. 1185/2003 (updated by EU Regulation No 605/2013) prohibits the removal of shark fins of these species, and subsequent discarding of the body. This regulation is binding on EC vessels in all waters and non-EC vessels in Community waters.

Whilst there is no agreed TAC for this stock, Council Regulation (EU) 2021/92 of 28 January 2021 identifies a catch limit of 288 537 t for EU fleets taking North Atlantic shortfin mako (SMA/AN05N). The associated conditions for this catch limit are that "*Only fish already dead when brought alongside the vessel can be retained on-board under this catch limit*" and that "*Only vessels with either an observer or a functioning electronic monitoring system on board, which can identify whether the fish is dead or alive, can retain on-board shortfin mako*".

9.3 Catch data

9.3.1 Landings

Nominal catch statistics stock, flag and gear, are presented in Table 9.1. Several updates were made to the historical catch series in 2017, namely for EU-Spain LLHB; South Africa; Japan (2014, 2015) and some other minor corrections (ICAT, 2017). For the rest of the flags, only the most recent years of official catches were added/updated and duly incorporated into T1NC. Substantial historical revisions have been made and the current Task I catches (new) were considered acceptable for use in the assessment models. As a result, the historical catches to be used in the 2017 assessment are lower than those documented in the Report of the 2012 Shortfin mako Stock Assessment (Anon., 2013).

In 2015, 3227 t of shortfin mako catch was reported to ICCAT (Table 9.1) in the North Atlantic (89% from longline fleets, the rest from sport fishing and other fleets). Landings have been relatively stable over recent decades. The main countries reporting catches in the North Atlantic in 2015 are Spain, Morocco, USA and Portugal, accounting for 42, 29, 16 and 7% respectively (Table 9.1). National landings reported to ICES for 2015 were 216 t for the northeast Atlantic, with the majority of this from Subarea 9.a by the UK. Smaller amounts were reported from areas 4, 6, 7 and 8, by Spain and the UK.

In the Mediterranean Sea, total reported landings to ICCAT were 0 t. Since 2007, reported landings in the Mediterranean Sea have been between 0–2 t.

Landings reported from the northeast Atlantic have been small in recent years (25 to 34 tonnes from 2016 to 2019). Further work is needed to check the consistency of landings data submitted in response to ICES data with ICCAT data.

9.3.2 Discards

Discard data are also given in Table 9.1, these are considered largely underestimated, with the USA longline being the fleet with the longest report of small amount of discards from 1987–1996 (1–38 t) and 2007–2015 (7–20 t). There are no reported discards from the Mediterranean Sea. Actual level of shortfin mako bycatch is difficult to estimate, as available data are limited and documentation is incomplete. A report of the US pelagic longline observer programme stated that of the sharks caught alive, 23% were released alive and 61% retained (ICCAT, 2005).

Shortfin mako shark discards (alive and dead) from Canadian fisheries in the Northwest Atlantic Ocean have been provided in 2017. The report includes records from all fisheries within the Canadian EEZ (both national and ICCAT managed) that capture Shortfin mako and the data is partitioned into live releases and dead discards (ICCAT, 2017).

Shortfin mako is a high value species, and many European fisheries land shortfin mako gutted (usually with the head on). Although often landed for their meat in some fisheries, finning (the practice of removing the fins of a shark and returning the remainder of the carcass to the sea) may occur for this species as well, which may result in undocumented catches and mortality in some fleets. Finning regulations are in force in various fisheries, but the extent of finning in IUU fisheries is unknown.

9.3.3 Quality of catch data

Catch data are considered underestimates, and the extent of finning in high seas fisheries is unclear. The historical use of generic shark categories is problematic, although many European countries have begun to report species-specific data in recent years. Despite some important recovery of historical catch series in recent years, ICCAT considers that the overall catch is underestimated, particularly before 2000.

There have been major discrepancies between reported landings in databases from ICCAT, FAO and EuroStat. The ICCAT Secretariat consolidated these three data sources into a unique database, and currently progress is being made on its validation and the associated data mining task (analysis of equivalent data series at various aggregation levels; Palma *et al.*, 2012). FAO data have been revised in recent years, and historical catch figures have increased from what was reported previously. The catches by FAO area (Figure 9.4) and the total North Atlantic catch are shown along with ICCAT catch totals (Figure 9.2) for comparison.

Previous ICCAT assessments of shortfin mako used two different estimates of landings for this stock, the tuna ratio (logged observations of shark catches relative to tuna catches) and the fin trade index (shark fin trade observations from the Asian market used to calculate caught shark weights based on catch effort data; Clarke *et al*., 2006; ICCAT 2005, 2008). These figures were much higher than reported landings.

The methodology adopted to estimate historic catches of blue shark was considered inappropriate for this species. It was noted that unlike the blue shark, shortfin mako has always had commercial value and thus discards have been less. So for shortfin mako, historical estimation of catches will be based on observer data, as well as other potential techniques. And where no additional information is available, catch ratios will be used to make these estimations. The highest priority for this exercise is given to Morocco, before 2011; EU-Spain, before 1997 and Canada, before 1995 (ICCAT, 2017).

9.3.4 Discard survival

Several studies have reported the at-vessel mortality of shortfin mako to broadly range from about 30–50% in longline fisheries (summarised in Ellis *et al.,* 2014 WD). Discard survival in such fisheries can be influenced by several factors, including hook type, soak time and size of shark.

9.4 Commercial catch composition

9.4.1 Conversion factors

Shortfin mako can be landed in various forms (e.g. gutted, dressed, with or without heads). It is therefore important that appropriate conversion factors for these landings are used. FAO (based on Norwegian data) use conversion factors for fresh, gutted, and gutted and headed sharks of 87% and 77%, respectively (Hareide *et al*., 2007). Scientific estimates for various conversion factors for shortfin mako are summarised for length–weight relationships (Table 9.2) and different length measurements (Table 9.3).

9.5 Commercial catch and effort data

Recent CPUE time series were provided for both the North and South Atlantic stocks along with a lowess smoother fitted to CPUE each year using a general additive model (GAM) to compare trends by stock (North Atlantic and South Atlantic) (Figure 9.5.). The overall trend for the Northern indices is an initial decrease followed by an increase from 2000 and a decline in the recent years. Residuals from the lowess fits to CPUE are compared to look at deviations from the overall trends (Figure 9.6.). This comparison allows conflicts between indices (e.g. highlighted by patterns in the residuals) and autocorrelation within indices (which may be due to year-class effects or the importance of factors not included in the standardization of the CPUE) to be identified.

Figure 9.7 presents the correlations between North Atlantic CPUE indices; the lower triangle shows the pairwise scatter plots between indices with a regression line, the upper triangle provides the correlation coefficients, and the diagonal provides the range of observations. The correlation between US observer and Chinese Taipei is high at 0.78; however, this is likely to be due to a single point (i.e. 2009). Also, a strong correlation could be found by chance if two series only overlap for a few years. Figure 9.8 shows the results from a hierarchical cluster analysis evaluated for the North Atlantic using a set of dissimilarities. All series appear to be similar, with the US observer and Chinese Taipei having the greatest similarity, but, as mentioned above, this could be due to one influential point. Cross-correlations for the North Atlantic are plotted in in Figure 9.8; the US logbook (3rd diagonal element) shows strong autocorrelation over 3 years, this could be due to year-class effects. This could also be a reason for strong cross-correlations between series. A strong negative or positive cross-correlation could be due to series being dominated by different age-classes, e.g. Portuguese longline and US observer has a negative lag of 2–3 that could be due to the US series catching younger individuals.

Although the relationship between Atlantic and Mediterranean Sea shortfin mako is unclear, Tudela *et al*. (2005) estimated CPUE based on driftnetters from Al Hoceima and Nador fishing in the Alboran Sea. Di Natale and Pelusi (2000) reported data from the Italian large pelagic longline fishery in the Tyrrhenian Sea (1998–1999), and calculated a mean CPUE of 1.1 kg per 1000 hooks.

9.6 Fishery-independent surveys

No fishery-independent data from the NE Atlantic are available.

Fishery-independent data are available from the NW Atlantic (Simpfendorfer *et al.*, 2002; Hueter and Simpfendorfer, 2008). Babcock (2010) provided an index of abundance of shortfin mako catch rates from the US East Coast from the National Marine Fisheries Service Marine Recreational Fishery Statistics Survey (MRFSS). A total of 711 shortfin mako were reported from 1981–2010. There were 252 686 trips of which about 0.2% caught at least one shortfin mako.

The NMFS (USA) also conducts a Cooperative Shark Tagging Programme (CSTP), which collaborates with the Shark Tagging Programme of Inland Fisheries Ireland (formerly the Irish Central Fisheries Board) (Green, 2007 WD; NMFS, 2006).

At the 2014 ICCAT Inter-sessional meeting of the shark subgroup, a Portuguese research project was presented on mitigation measures for shark bycatch in pelagic longline fisheries. An electronic tagging experiment will be carried out during this research project to evaluate post-release mortality of shortfin mako.

There is a large set of mark-recapture data available at ICCAT for shortfin mako shark, with 9316 individuals tagged since 1962 and 1255 specimens recaptured (ICCAT, 2016). The ICCAT Shark Species Group suggested that these data could be used to provide information for the growth curve, and proposed an age and growth workshop for shortfin mako in 2017 (ICCAT, 2016).

9.7 Life-history information

Various studies have provided biological information for this species (see also Stevens, 2008). Data available for the North Atlantic stock are given in Table 9.2 (length–weight relationships), Table 9.4 (growth parameters), and Table 9.5 (other life-history parameters).

There was also an update of life-history parameters in the report of the 2014 inter-sessional meeting of the ICCAT shark sub-group (ICCAT, 2014) and again in 2017 (ICCAT, 2016). At the 2017 ICCAT SMA data-preparatory meeting, it was decided that the two phases of the Shark Research and Data Collection Plan were devoted to shortfin mako shark, as the species to be assessed in 2017. While considerable work has been produced, there are still uncertainties on some important biological parameters and it is important to continue the work that has been started on this species. Additionally, ICCAT Recommendation 14–06 on shortfin mako caught in association with ICCAT fisheries supports this in saying that: "Paragraph 3: *CPCs are encouraged to undertake research that would provide information on key biological/ecological parameters, life-history and behavioural traits, as well as on the identification of potential mating, pupping and nursery grounds of shortfin mako sharks. Such information shall be made available to the SCRS*". As such, the Group recommends that it is important to continue the shortfin mako shark work and allocate part of the new funds for this species to continue this work.

9.7.1 Habitat

Shortfin mako is a common, extremely active epipelagic species found in tropical and warm-temperate seas from the surface down to at least 500 m (Compagno, 2001). The species is seldom found in waters <16°C, and in the western North Atlantic they only move onto the continental shelf when surface temperatures exceed 17°C. Observations from South Africa indicate that the species prefers clear water (Compagno, 2001).

9.7.2 Nursery grounds

Published records of potential nursery grounds are lacking. Buencuerpo *et al.* (1998) suggested that the western basin of the Mediterranean Sea was a nursery area. Stevens (2008) suggested that nursery areas would likely be situated close to the coast in highly productive areas, based on the majority of reports, with nursery grounds potentially off West Africa in the North Atlantic.

9.7.3 Diet

Shortfin mako feed primarily on fish, both pelagic and demersal species, and cephalopods (Compagno, 2001). Shortfin mako sampled off southwest Portugal had teleosts as the principal component of their diet (occurring in 87% of the stomachs and accounting for >90% of the contents by weight), and crustaceans and cephalopods were also relatively important, whilst other elasmobranchs were only present occasionally (Maia *et al*., 2006).

In the NW Atlantic, bluefish *Pomatomus saltatrix* is the most important prey species and comprises about 78% of the diet (Stillwell and Kohler, 1982). These authors estimated that a 68 kg shortfin mako consumes about 2 kg of prey per day, and could eat about 8–11 times its body weight per year. Stillwell (1990) subsequently suggested that shortfin mako may consume up to 15 times their weight per year.

The diet of shortfin mako in South African waters indicated that elasmobranchs could be important prey, and marine mammals can also make up a small proportion of the diet (Compagno, 2001).

9.7.4 Movements

Shortfin mako sharks have a wide distribution and habitat use patterns (Casey and Kohler, 1992; Rogers *et al*. 2015; Vaudo *et al*. 2016). The species showed diel diving behaviour, with deeper dives occurring primarily during the daytime. A strong influence of thermal habitat on species movement behaviour suggests potentially strong impacts of rising ocean temperatures on the ecology of this highly migratory top predator. Integrating knowledge of fish movements into spatially explicit population dynamics models is being urged for improving stock assessments and management (Braccini, Aires-da-Silva and Taylor 2016).

9.8 Exploratory assessment models

No new exploratory assessment was undertaken.

9.9 Stock assessment

An ICCAT assessment for shortfin mako was carried out in 2017 (ICCAT, 2017). The models agreed that the northern stock was overfished and was undergoing overfishing. The results obtained in this evaluation are not comparable with those obtained in the last assessment in 2012 because the input data and model structures have changed significantly. ICCAT considered the stock status results for the South Atlantic to be highly uncertain. Despite this uncertainty, it was not possible for ICCAT to discount that in recent years the stock may have been at, or already below, B_{MSY} and that fishing mortality was already exceeding F_{MSY}.

ICCAT updated the assessment for shortfin mako in 2019. New projections were made using two Stock Synthesis model scenarios that incorporated important aspects of shortfin mako biology, which had not been available previously (ICCAT, 2019). These projections were considered by the ICCAT Shark Group as a better representation of the stock dynamics. For the North Atlantic stock, the Group stated that "it is likely the current status (2018) had a lower B/B_{MSY} and higher F/F_{MSY} than the stock status in 2015 estimated in the 2017 assessment because the population continued to decline due to high catch levels". A number of catch scenarios are given in the report, but the Group states that "regardless of the TAC (including a TAC of 0 t), the stock will continue to decline until 2035 before any biomass increases can occur" and "although there is large uncertainty in the future productivity assumption for this stock, the Stock Synthesis projections show that there is a long lag time between when management measures are implemented and when stock size starts to rebuild" (ICCAT, 2019).

9.10 Quality of assessment

Assessments undertaken by ICCAT are conditional on several assumptions, including the estimates of historical shark catch, the relationship between catch rates and abundance, the initial state of the stock, as well as uncertainty in some life-history parameters.

9.11 Reference points

ICCAT uses F/F_{MSY} and B/B_{MSY} as reference points for stock status. These reference points are relative metrics. The absolute values of B_{MSY} and F_{MSY} depend on model assumptions and results and are not presented by ICCAT for advisory purposes.

9.12 Conservation considerations

Shortfin mako was listed as 'Near Threatened' until 2008 when it was up listed to 'Vulnerable' both globally and regionally in the North Atlantic in the IUCN Red List (Cailliet *et al*., 2009).

In 2006, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) designated the Atlantic population of the shortfin mako as threatened (DFO, 2006).

9.13 Management considerations

Shortfin mako shark is one of the most common species in the global fin trade (Clarke *et al*. 2006). Thus, fishery exploitation is a major source of mortality for mako shark populations, which, because of their life-history characteristics, have a high risk of overexploitation (Cortés *et al*. 2010). Despite this risk, mako shark management is limited as there is a great deal of uncertainty in population estimates because of sparse biological information on the species, including its movement ecology (E. Cortés, pers. comm).

Catch data of pelagic sharks are considered unreliable, as many sharks are not reported on a species-specific basis, and some fisheries may have only landed fins. As already stated, the landings data are unreliable and particularly pre-2000 should be considered an underestimate. Reporting procedures must be strengthened so that all landings are reported, and that landings are reported to species level, rather than generic "*nei*" categories. The consolidation of three databases (ICCAT, FAO and EUROSTAT) by the ICCAT Secretariat should also strengthen the reliability of catch data in the future.

The 2019 Report of the Standing Committee on Research and Statistics (SCRS) stated that, "*i) a zero TAC will allow the stock to be rebuilt and without overfishing (in the green quadrant of the Kobe plot) by 2045 with a 53% probability; ii) regardless of the TAC (including a TAC of 0 t), the stock will continue to decline until 2035 before any biomass increases can occur; iii) a TAC of 500 t, including dead discards has only a 52% probability of rebuilding the stock to the green quadrant in 2070; iv) to be in the green quadrant of the Kobe plot with at least 60% probability by 2070, the realized TAC has to be 300 t or less; v) lower TACs achieve rebuilding in shorter time frames; and vi) a TAC of 700 t would end overfishing immediately with a 57% probability, but this TAC would only have a 41% probability of rebuilding the stock by 2070.*" (ICCAT, 2019). Furthermore, "*Given the vulnerable biological characteristics of this stock and the pessimistic projections, to accelerate the rate of recovery and to increase the probability of success the Committee recommends that the Commission adopt a non-retention policy without exception in the North Atlantic as it has already done with other shark species caught as bycatch in ICCAT fisheries*".

In 1995, the Fisheries Management Plan for pelagic sharks in Atlantic Canada established a catch limit of 100 t annually for the Canadian pelagic longline fishery as well as advising release of live catch.

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Table 9.1. Shortfin mako in the North Atlantic (ATN) South Atlantic (STN) and Mediterranean (MED). Available landings (t) of shortfin mako by country from ICCAT Task I catch data. These data are considered underestimates, especially prior to 2000. Landings of <0.5 t are data for 2012, 2013 and 2014 from ICCAT (2015). Landings for ATN Sport and other gear codes are given as one value from 2012 onwards.

				1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
TOTAL				5841	8406	7701	5727	5861	4469	5179	4792	5531	7225	6528	6970	6620	6946	5682	6605	7254	6979	7338	5778	6126	5739	6111	5902	5547
	ATN			3659	5306	5306	3534	3845	2858	2587	2677	3426	3987	4000	3695	3574	4158	3800	4541	4767	3718	4431	3595	2852	2964	3347	3116	2388
	ATS			2182	3100	2395	2187	2008	1606	2588	2107	2103	3235	2526	3259	3036	2786	1881	2063	2486	3258	2905	2183	3274	2774	2765	2786	3158
	MED			0	0	0	6	8	5	4	7	2	2	2	17	10	2	1	1	2	2	2	0	0	0	0	0	1
Landings	ATN		Longline	3306	3828	5053	3351	3670	2756	2267	2446	3155	3970	3572	3387	3302	3976	3622	4344	4587	3496	4145	3312	2576	2638	3118	2713	1990
			Other surf.	331	1448	252	183	175	99	320	231	271	17	429	308	273	175	169	177	178	213	267	278	264	316	221	397	369
	ATS		Longline	2161	3085	2379	2163	1996	1596	2565	2090	2088	3204	2450	3245	2992	2745	1799	2057	2485	3196	2842	2149	3241	2760	2748	2620	3149
			Other surf.	21	15	16	25	12	10	22	18	15	31	76	14	43	30	82	7	1	62	55	34	31	12	13	162	7
	MED		Longline	0	0	0	6	8	5	4	7	2	2	2	17	10	2	1	1	2	2	2	0	0	0	0	0	
			Other surf.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Discards	ATN		Longline	21	29	1	0	0	0	0	0	0	0	0	0	0	7	9	20	2	9	19	5	12	10	8	4	28
			Other surf.	0	0	0	0	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1
	ATS		Longline	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	8	0	2	2	3	3	2
			Other surf.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
	MED		Longline	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Landings	ATN	CP	Barbados	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	3	3	**0**
			Belize	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23	28	69	114	99	1	1	1	9	12
			Brazil	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Canada	0	111	67	110	69	70	78	69	78	73	80	91	71	72	43	53	41	37	29	35	55	85	82	109	53
			China PR	0	0	0	0	0	0	0	0	0	0	0	0	0	81	16	19	29	18	24	11	5	2	4	2	**0**
			Curaçao	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			EU.España	2164	2209	3294	2416	2223	2051	1561	1684	2047	2068	2088	1751	1918	1814	1895	2216	2091	1667	2308	1509	1481	1362	1574	1784	1165
			EU.France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	2	0	0	0	1	1	2	1	0
			EU.Netherlands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			EU.Portugal	649	657	691	354	307	327	318	378	415	1249	473	1109	951	1540	1033	1169	1432	1045	1023	820	219	222	264	276	272
			EU.United Kingdom	0	0	0	0	0	2	3	2	1	1	1	0	0	0	1	15	0	0	0	0	0	0	0	0	**0**
			FR.St Pierre et Miquelon	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	4	0	0	4	0	0	0	0	**0**
			Guatemala	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Japan	214	592	790	258	892	120	138	105	438	267	572	0	0	82	131	98	116	53	56	33	69	45	74	89	20
			Korea Rep.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	27	27	15	8	2	1	3	5
			Maroc	0	0	0	0	0	0	0	0	0	147	169	215	220	151	283	476	636	420	406	667	624	947	1050	450	594
			Mauritania	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	**0**
			Mexico	0	10	0	0	0	0	10	16	0	10	6	9	5	8	6	7	8	8	8	4	4	4	3	5	2
			Panama	0	0	0	0	0	1	0	0	0	0	0	0	0	49	33	39	0	0	0	19	7	0	0	0	**0**
			Philippines	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	
			Senegal	0	0	0	0	0	0	0	0	0	0	0	0	0	8	17	21	0	0	2	0	2	2	2	68	68
			St. Vincent and Grenadines	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	**0**
			Trinidad and Tobago	0	0	0	0	0	1	0	1	2	3	1	2	1	1	1	1	1	0	2	1	1	1	1	2	2
			U.S.A.	574	1658	400	345	296	198	414	350	372	106	477	422	353	319	296	314	335	331	365	355	345	255	262	299	165
			UK.Bermuda	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Venezuela	7	7	17	9	8	6	9	24	21	28	64	27	14	19	8	41	27	20	33	9	13	7	7	9	
		NCC	Chinese Taipei	29	32	45	42	47	75	56	47	53	37	70	68	40	6	23	11	14	13	14	8	4	13	7	1	**0**

				1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
		NCO	Sta. Lucia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	
	ATS	CP	Angola	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31	0
			Belize	0	0	0	0	0	0	0	0	0	0	0	38	0	17	2	0	32	59	78	88	1	15	14	34	15
			Brazil	95	119	83	190	233	27	219	409	226	283	238	426	210	145	203	99	128	192	196	276	268	173	124	275	399
			China PR	45	23	27	19	74	126	305	22	208	260	68	45	70	77	6	24	32	29	8	9	9	5	3	1	0
			Curaçao	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Côte d'Ivoire	20	13	15	23	10	10	9	15	15	30	15	14	16	25	0	5	7	0	20	34	19	11	13	161	4
			EU.España	552	1084	1482	1356	984	861	1090	1235	811	1158	703	584	664	654	628	922	1192	1535	1207	1083	1077	862	882	1049	1044
			EU.Portugal	0	92	94	165	116	119	388	140	56	625	13	242	493	375	321	502	336	409	176	132	127	158	393	503	300
			EU.United Kingdom	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	11	0	0	0	0	0	0	0	0	0
			El Salvador	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Guatemala	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Japan	1369	1617	514	244	267	151	264	56	133	118	398	0	0	72	115	108	103	132	291	114	182	109	77	96	93
			Korea Rep.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	29	13	7	7	4	4	18	8	9
			Namibia	0	0	0	0	0	1	0	0	459	375	509	1415	1243	1002	295	23	307	377	586	9	950	661	799	194	980
			Panama	0	0	0	0	0	24	1	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0
			Philippines	0	0	0	0	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	
			Russian Federation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Senegal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	34	23	0	11	6	39	4
			South Africa	24	49	37	31	171	67	116	70	12	116	101	111	86	224	137	146	152	218	108	250	476	613	339	305	244
			UK.Sta Helena	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Uruguay	12	17	26	20	23	21	35	40	38	188	249	146	68	36	41	106	23	76	36	1	0	0	0	0	0
			Vanuatu	0	0	0	0	0	0	0	0	0	0	52	12	13	1	0	0	0	0	0	0	0	0	0	0	0
		NCC	Chinese Taipei	65	87	117	139	130	198	162	120	146	83	180	226	166	147	124	117	144	203	150	157	158	152	92	85	64
	MED	CP	EU.Cyprus	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0
			EU.España	0	0	0	6	7	5	3	2	2	2	2	2	4	1	0	0	1	2	2	0	0	0	0	0	0
			EU.France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			EU.Italy	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
			EU.Portugal	0	0	0	0	1	0	1	5	0	0	0	15	5	0	0	0	0	0	0	0	0	0	0	0	0
			Japan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Maroc	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Discards	ATN	CP	Canada	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2
			Curaçao	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			EU.España	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			EU.France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			El Salvador	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Guatemala	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Japan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24
			Korea Rep.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	
			Mexico	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Panama	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Russian Federation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			U.S.A.	21	28	1	0	0	0	0	0	0	0	0	0	0	7	10	20	2	9	18	5	11	8	6	4	1
			UK.Bermuda	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		NCC	Chinese Taipei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	3
	ATS	CP	Brazil	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	
			Curaçao	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

			1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
		EU.España	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		EU.France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
		El Salvador	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Guatemala	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Korea Rep.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Panama	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	NCC	Chinese Taipei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	2	2	3	3	2
MED	CP	EU.España	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

Table 9.2. Shortfin mako in the North Atlantic. Length–weight relationships for *Isurus oxyrinchus* (sexes combined) from different populations. Lengths in cm, and weights in kg unless specified in equation. W_R = round weight; W_D = dressed weight.

Stock	L (cm) W (kg) relationship	n	Length range (cm)	Source
Central Pacific	log W (lb) = –4.608 + 2.925 x log L_T			Strasburg, 1958
Cuba	W = 1.193 x 10–6 x L_T 3.46	23	160–260 (L_T)	Manday, 1975
Australia	W = 4.832 x 10–6 x L_T 3.10	80	58–343 (L_T)	Stevens, 1983
South Africa	W = 1.47 x 10–5 x L_{PC} 2.98	143	84–260 (L_{PC})	Cliff *et al*., 1990
NW Atlantic	W_R = (5.2432 x 10–6) L_F 3.1407	2081	65–338 (L_F)	Kohler *et al*., 1995.
NW Atlantic	W = 7.2999 x L_T (m) 3.224	63	2.0–3.7 m (L_T)	Mollet *et al*., 2000
Southern hemisphere	W = 6.824 x L_T (m) 3.137	64	2.0–3.4 m (L_T)	Mollet *et al*., 2000
NE Atlantic	W_D = (2.80834 x 10–6) L_F 3.20182	17	70–175 (L_F)	García-Cortés and Mejuto, 2002
Tropical east Atlantic	W_D = (1.22182 x 10–5) L_F 2.89535	166	95–250	García-Cortés and Mejuto, 2002
Tropical central Atlantic	W_D = (2.52098 x 10–5) L_F 2.76078	161	120–185	García-Cortés and Mejuto, 2002
Southwest Atlantic	W_D = (3.1142 x 10–5) L_F 2.7243	97	95–240	García-Cortés and Mejuto, 2002

Table 9.3. Shortfin mako in the North Atlantic. Length–length relationships for male, female and sexes combined from the NE Atlantic and Straits of Gibraltar (L_S = standard length; L_F = fork length; L_T = total length; L_{UC} = upper caudal lobe length). Source: Buencuerpo *et al*. (1998).

Females	Males	Combined
L_F = 1.086 L_S + 1.630 (n=852)	L_F = 1.086 L_S + 1.409 (n=911)	L_F = 1.086 L_S + 1.515 (n=1763)
L_T = 0.817 L_S + 0.400 (n=852)	L_T = 1.209 L_S + 0.435 (n=681)	L_T = 1.207 L_S + 0.971 (n=1533)
L_{UC} = 3.693 L_S + 13.094 (n=507)	L_{UC} = 3.795 L_S + 10.452 (n=477)	L_{UC} = 3.758 L_S + 11.640 (n=1054)
L_T = 1.106 L_F + 0.052 (n=853)	L_T = 1.111 L_F – 0.870 (n=911)	L_T = 1.108 L_F – 0.480 (n=1746)

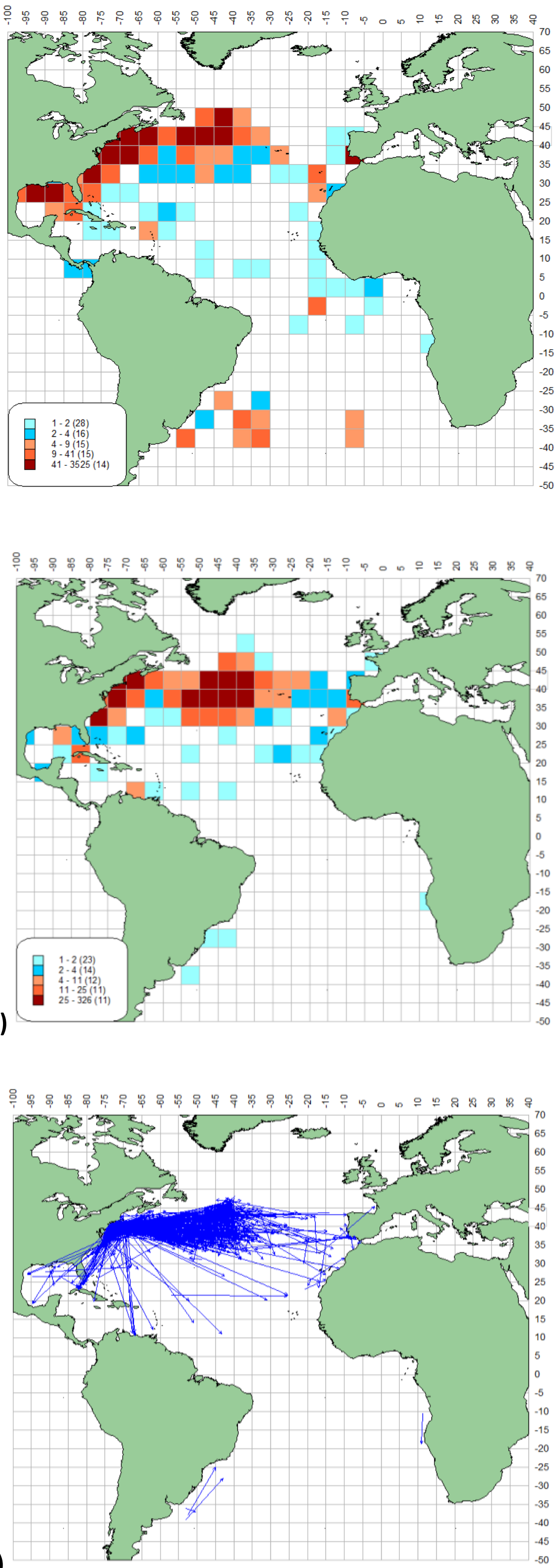
Table 9.4. Shortfin mako in the North Atlantic. Published growth parameters, assuming two vertebral bands formed annually. Data give von Bertalanffy growth parameters (Gompertz growth function) used, t_0 in cm. L_∞ in cm (Fork Length), k in years^{-1}.**

Area	L∞	k	t_0	Sex	Study
Northwest Atlantic	302	0.266	–1	Male	Pratt and Casey, 1983
Northwest Atlantic	345	0.203	–1	Female	Pratt and Casey, 1983
Atlantic	373.4	–0.203	1.0	Female	Cortés, 2000
Northwest Atlantic	253	0.125	71.6	Male	Natanson *et al*., 2006**
Northwest Atlantic	366	0.087	88.4	Female	Natanson *et al*., 2006**

Table 9.5. Shortfin mako in the North Atlantic. Life-history information available from the scientific literature.

Parameter	Values	Sample Size	Area	Reference
Reproduction	Ovoviviparous with oophagy			Campana *et al*., 2004
Litter size	4–25	35	Worldwide	Mollet *et al*., 2000
	12–20			Castro *et al*., 1999
Size at birth (L_T)	70 cm	188+	Worldwide	Mollet *et al*., 2000
Sex ratio (males: females)	1:1	2188	NW Atlantic	Casey and Kohler, 1992
	1:0.4		NE Atlantic (Spain, Azores)	Mejuto and Garces, 1984
	1:0.9		NE, N central Atlantic and Med	Buencuerpo *et al*., 1998
	1.0:1.4	17	NE Atlantic	García-Cortés and Mejuto, 2002
Gestation period	15–18	26	Worldwide	Mollet *et al*., 2000
Male age-at-first maturity (years)*	2.5			Pratt and Casey, 1983
	9			Cailliet *et al*., 1983
Male age-at-median maturity (years)	7	145	New Zealand	Bishop *et al*., 2006
Female age-at-first maturity (years)*	5			Pratt and Casey, 1983
Female age maturity (years)	19	111	New Zealand	Bishop *et al*., 2006
	7			Pratt and Casey, 1983
Male length-at-first maturity (T_L)	195 cm			Stevens, 1983
Male length-at-maturity (T_L)	197–202 cm (median)	215	New Zealand	Francis and Duffy, 2005
	180 cm (L_F)		NE Atlantic (Portugal)	Maia *et al*., 2007
	200–220		Worldwide	Pratt and Casey, 1983; Mollet *et al*., 2000
Female length-at-first maturity (T_L)	265–280 cm			Cliff *et al*., 1990
Female length-at-maturity (T_L)	301–312 (median)	88	New Zealand	Francis and Duffy, 2005
	270–300 cm (L_T)		Worldwide	Pratt and Casey, 1983; Mollet *et al*., 2000
Age-at-recruitment (year)	0–1			Stevens and Wayte, 1999
Male maximum length (L_T)	296 cm			Compagno, 2001
Female maximum length (L_T)	396 cm 408 cm (estimated)			Compagno, 2001
Lifespan (years)	11.5–17 (oldest aged)			Pratt and Casey, 1983

Parameter	Values	Sample Size	Area	Reference
	45 (estimated longevity)			Cailliet *et al.*, 1983
Natural mortality (M)	0.16		Pacific	Smith *et al.*, 1998
Annual survival estimate	0.79 (95% C.I. 0.71–0.87)			Wood *et al*. 2007
Growth parameters	61.1 cm year–1 first year 40.6 cm year–1 second year 5.0 cm month–1 in summer 2.1 cm month–1 in winter	262	NE Atlantic (Portugal)	Maia *et al.*, 2007
Maximum age (estimated from von Bertalanffy growth eqn.)	28			Smith *et al.*, 1998
Productivity (R2m) estimate: intrinsic rebound	0.051 (assuming no fecundity increase)		Pacific	Smith *et al.*, 1998
Potential rate of increase per year	8.5%		Atlantic	Cortés, 2000
Population doubling time T_D (years)	13.6 (assuming no fecundity increase)		Pacific	Smith *et al.*, 1998
Generation time (years)	~ 9		Atlantic	Cortés, 2000
Trophic level	4.3	7		Cortés, 1999



a)

b)

c)

Figure 9.1. Shortfin mako in the North Atlantic. Tag and release distributions for shortfin mako in the Atlantic Ocean showing (a) density of releases, (b) density of recoveries, and (c) straight displacement between release and recovery locations. Recaptures were 13.4%. Source: ICCAT (2014).

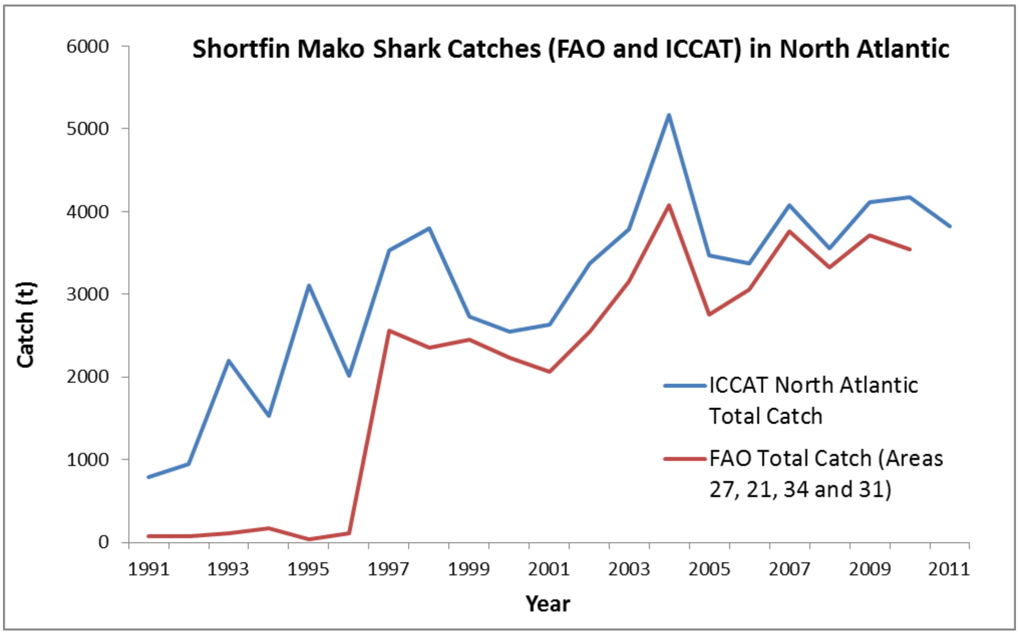


Figure 9.2. Shortfin mako in the North Atlantic. Total catches (t) of shortfin mako in the North Atlantic reported to FAO and ICCAT.

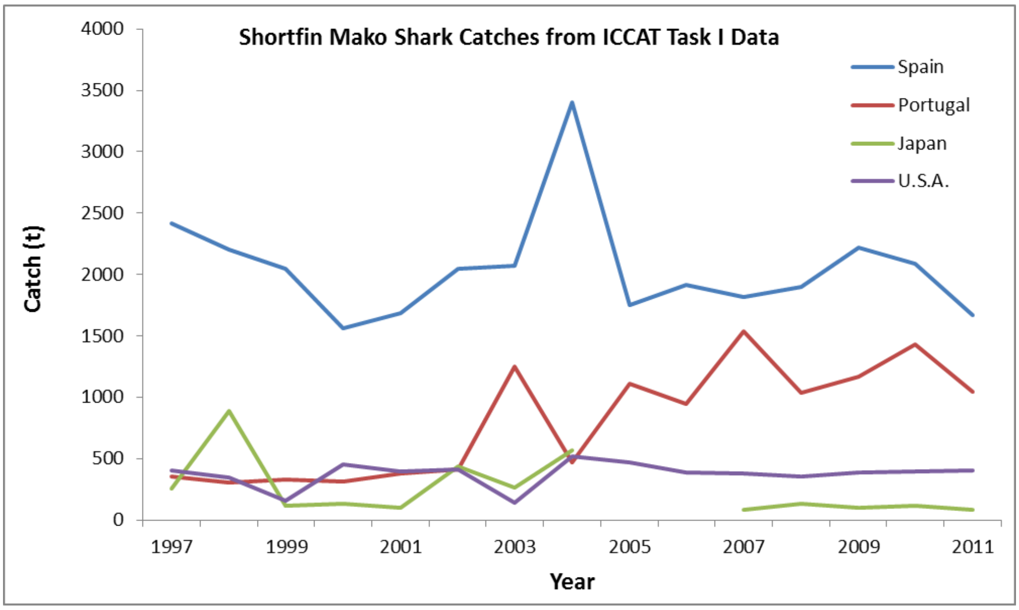


Figure 9.3. Shortfin mako in the North Atlantic. Total catches (t) made by the major countries (accounting for 84% of total landings) landing shortfin mako in the North Atlantic reported to ICCAT.

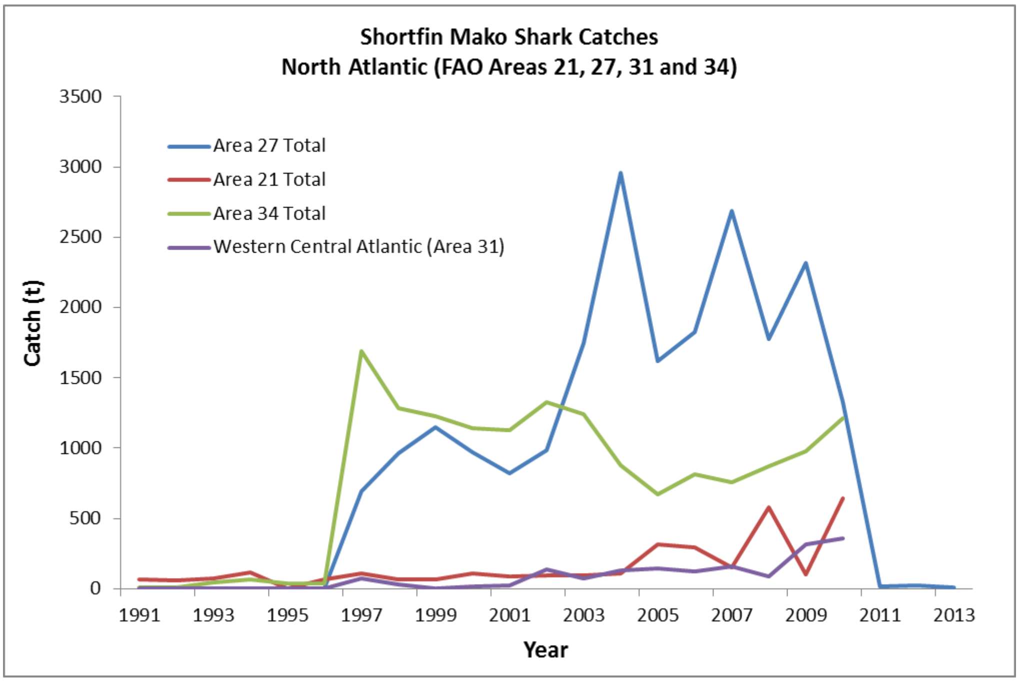


Figure 9.4. Shortfin mako in the North Atlantic. Total catches (t) of shortfin mako reported to FAO by major fishing area.

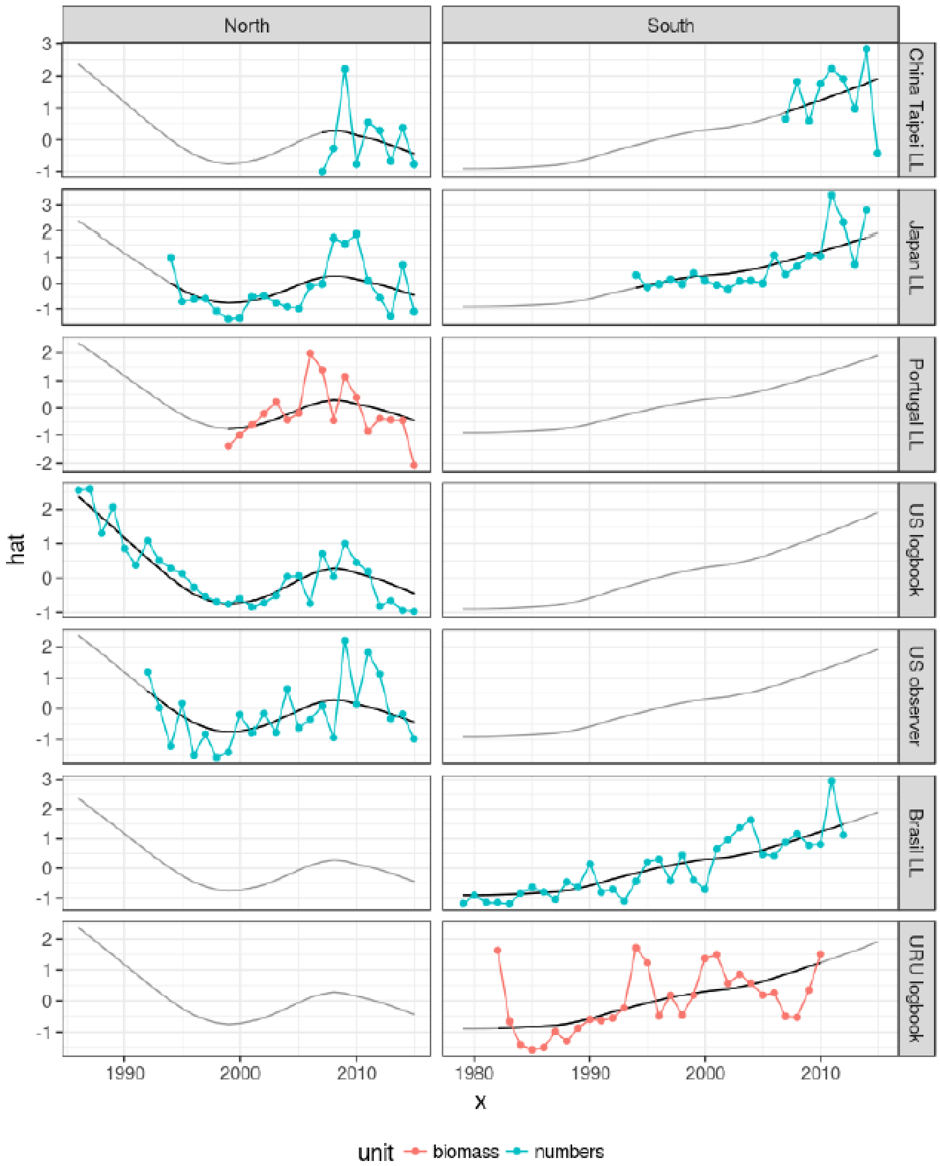


Figure 9.5. Shortfin mako in the North and South Atlantic. Time series of agreed CPUE indices, points are the standardised values, continuous black lines are a loess smoother showing the average trend by area (i.e. fitted to year for each area with series as a factor). X-axis is time, Y-axis are the scaled indices. Source: ICCAT.

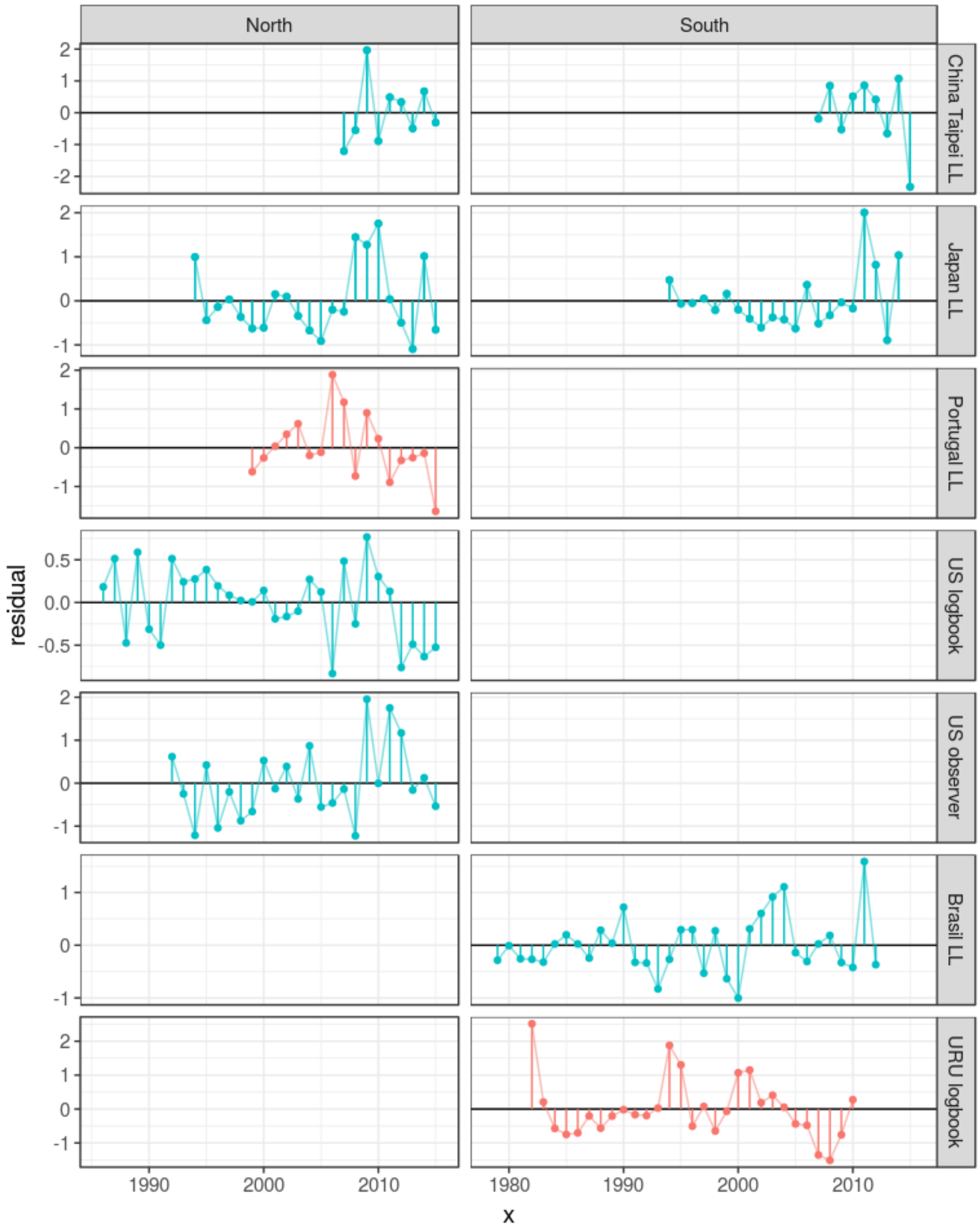


Figure 9.6. Shortfin mako in the North and South Atlantic. North and South Atlantic time series of residuals from the loess fit to agreed indices. X-axis is time, Y-axis are the scaled indices. Source: ICCAT.

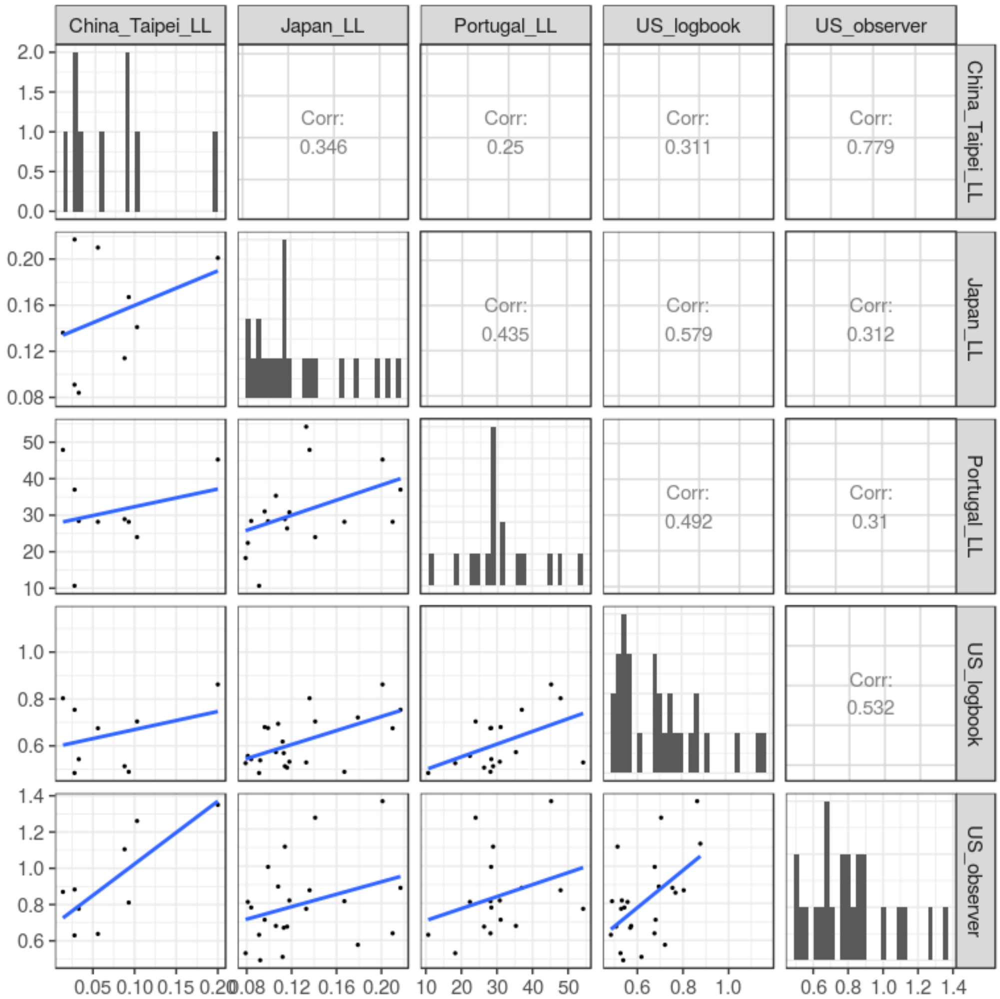


Figure 9.7. Shortfin mako in the North Atlantic. North Atlantic pairwise scatter plots for agreed indices. X- and Y-axis are scaled indices. Source: ICCAT.

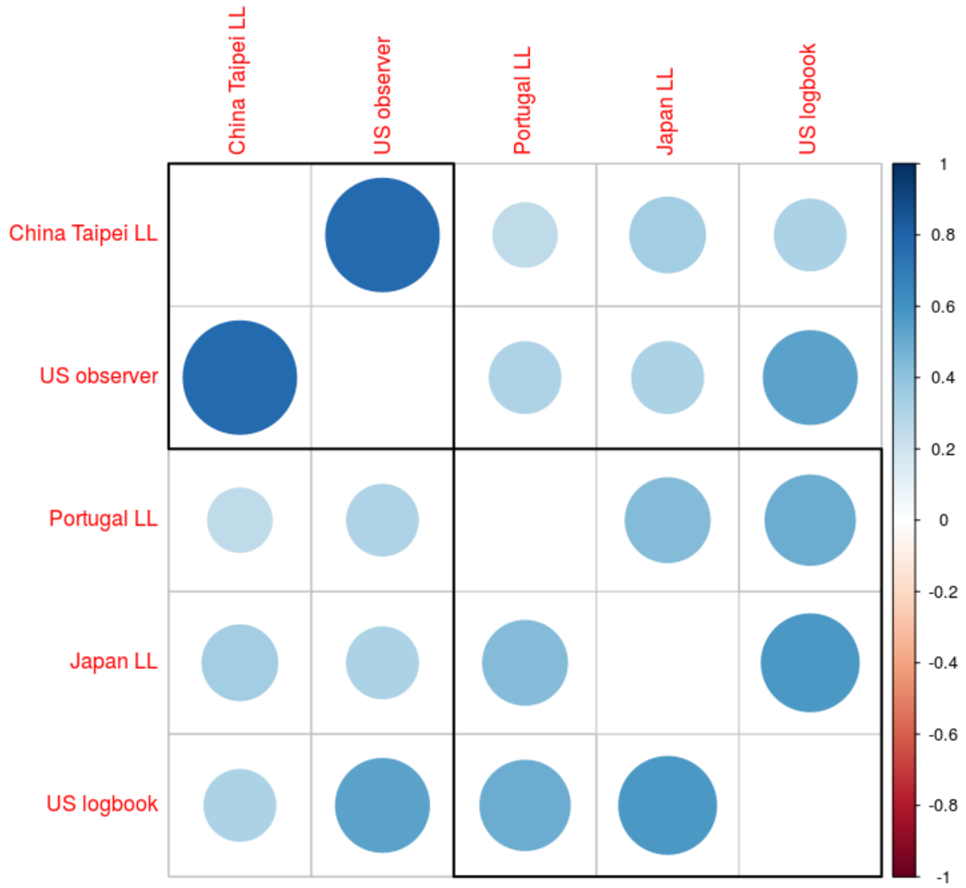


Figure 9.8. Shortfin mako in the North Atlantic. North Atlantic correlation matrix for the agreed indices; blue indicates positive and red negative correlations, the order of the indices and the rectangular boxes are chosen based on a hierarchical cluster analysis using a set of dissimilarities. Source: ICCAT.

10 Tope in the Northeast Atlantic

10.1 Stock distribution

WGEF considers there to be a single stock of tope (or school shark) *Galeorhinus galeus* in the ICES area. This stock is distributed from Scotland and southern Norway southwards to the coast of Northwest Africa and the Mediterranean Sea. The stock area covers ICES subareas 2–10 (where subareas 4 and 6–10 are important parts of the stock range, and subareas 2, 3 and 5 areas where tope tend to be an occasional vagrant). The stock extends into the northern part of the CECAF area and the Mediterranean Sea (Subareas I–III). The information used to identify the stock unit is summarized in the stock annex (ICES, 2009).

10.2 The fishery

10.2.1 History of the fishery

Currently there are no targeted commercial fisheries for tope in the NE Atlantic. Tope is discarded in some fisheries but landed as a bycatch in trawl, gillnet and longline fisheries, including demersal and pelagic static gears.

Tope is also an important target species for recreational sea angling in several areas, with anglers, angling clubs and charter boats often having catch and release protocols.

10.2.2 The fishery in 2020

The impact of the COVID-19 pandemic on fishing activity, though so far unquantified, may be assumed, depending on national or local restrictions, to have reduced fishing effort in place for at least some of the year.

10.2.3 ICES Advice applicable

ICES provided advice for this stock for the first time in 2012, stating "*Based on ICES approach to data-limited stocks, ICES advises that catches should be reduced by 20%. Because the data for catches of tope are not fully documented and considered unreliable (due to the historical use of generic landings categories), ICES is not in a position to quantify the result. Measures to identify pupping areas should be taken*".

In 2019, ICES advised that "*when the precautionary approach is applied, landings should be no more than 301 tonnes in each of the years 2020 and 2021. ICES cannot quantify the corresponding catches*".

10.2.4 Management applicable

In 2015, EC regulations for fishing opportunities first prohibited EU vessels from fishing for, retaining on board, transhipping or landing tope when captured on longlines in European Union waters of ICES Division 2.a and Subarea 4 and in Union and international waters of ICES subareas 1, 5–8, 12 and 14 (Council Regulation (EU) 2015/104). These prohibitions on longline-caught tope continue to apply in UK waters.

The UK's Department for Environment, Food and Rural Affairs (DEFRA) introduced a Statutory Instrument in 2008 (SI Number 2008/691, "The Tope Order") that prohibited fishing for tope other than by rod and line (with anglers fishing using rod and line from boats not allowed to land their catch) and established a tope bycatch limit of 45 kg per day in commercial fisheries. In Scotland, vessels are prohibited from fishing for tope, other than by rod and line or hand-line, trans-shipment of tope caught by rod and line or hand-line (wherever caught) and, landing tope (wherever caught) as per Statutory Instrument in 2012 (SI Number 2012/63, "The Sharks, Skates and Rays (Prohibition of Fishing, Trans-shipment and Landing) (Scotland) Order 2012").

10.3 Catch data

10.3.1 Landings

No accurate estimates of historical catch are available, as many nations that land tope report an unknown proportion of landings in aggregated landings categories (e.g. dogfish and hounds). In other cases, misidentification/misreporting of other species as tope may have taken place.

Reported species-specific landings, which commenced in 1978 for French fisheries, are given in Table 10.1, based on data collated by WGEF up to and including 2020. Prior to, and at WGEF 2016, landings from 2005–2015 were reassessed, and where possible, erroneous or generic species categories or figures were reassigned following WKSHARK2 (ICES, 2016a). The data supplied to WGEF are higher than previous data, although of a similar magnitude, and the reasons for these discrepancies are still to be investigated.

Recent estimated landings data from 2005–2020 for tope are shown by fishing area (Table 10.2) and by nation (Table 10.3), following the procedure from WKSHARK2. Overall, landings data appear relatively stable in recent years, although have decreased since 2019 (Figure 10.1; Table 10.2; Table 10.3). The 2020 estimated landings are the lowest observed in the last decade, however, these should be viewed with care as the COVID-19 pandemic may have contributed to a reduction on fishing activity and thus, on reported landings.

France is one of the main nations landing tope, accounting for ca. 75–80% in 2019 and 2020, with the English Channel and Celtic Seas important fishing grounds. UK fisheries also land tope, although species-specific data are lacking for the earlier years, and reported landings have declined since precautionary management measures (trip limits of no more than 45 kg per day) were introduced.

Since 2001, Ireland, Portugal and Spain have also declared species-specific landings. However, it is believed that some of the Portuguese landings recorded as tope may also include unknown proportions of other sharks, including smooth-hounds and deep-water sharks. Portuguese tope landings for 2017 were examined by IPMA scientists and have been corrected, which explains values for this year to be less than declared in previous years. The main Portuguese landings of tope are recorded from areas around the Azores.

The introduction of management restrictions in 2015 applicable to Subarea 7 and 8 (see Section 10.2.4) may have, alongside with unavailable data from FAO areas 34 and 37, contributed to the decrease in 2015–2020 landings reported by Spain (Table 10.3).

Limited species-specific catch data for the Mediterranean Sea and off northwest Africa are available. The degree of possible misreporting or underreporting is not known.

10.3.2 Discards

Though some discard information is available from various nations, data are limited for most nations and fisheries.

Data analysis from the UK (E&W) observer programme (Silva and Ellis, 2019) suggested that the introduction of the Tope (Prohibition of Fishing) Order 2008, may have influenced the discard-retention patterns (Figure 10.2). This change was more evident on tope caught in drift and static gillnet fisheries where the proportion of discards increased from 11% (2002–2007) to 67% (2008–2016). No apparent change was observed by otter trawlers, with similar levels for both time periods (ca. 77%).

The small number of tope recorded in some discard observer programmes may be an artefact of limited coverage on those vessels that may encounter them, and the occasional and seasonal occurrence of tope in some areas. Sporadic records of tope in observer data indicate that appropriate methods of raising such discard data to fleet need to be evaluated if catch advice is to be developed.

In 2017, ICES held a workshop (WKSHARK3) to compile and refine catch and landings of elasmobranchs (ICES, 2017). National data were examined for UK (England), Ireland, France and Spain (Basque country) for two main gear categories: otter trawl and gillnet. Discard data were also provided as part of the 2017–2021 Data Call. However, data available were insufficient to draw a more comprehensive interpretation of any discard/retention patterns (see also Section 1.14).

10.3.3 Quality of catch data

Catch data are of poor quality, and biological data are not collected under the Data Collection Regulations. Some generic biological data are available (see Section 10.7).

10.3.4 Discard Survival

Ellis *et al.* (2014 WD; 2017) provided references for discard survival of shark species worldwide. Discard survival of members of the Triakidae family appears to be quite variable. Whilst quantitative data are limited in European waters, Fennessy (1994) reported at-vessel mortality (AVM) of 29% for Arabian smooth-hound *Mustelus mosis* taken in a prawn trawl fishery. AVM ranged from 57–93% for three triakid sharks taken in an Australian gillnet fishery, despite the soak times being < 24 hours (Braccini *et al*., 2012). Lower AVM of triakids has been reported in longline fisheries (Frick *et al*., 2010; Coelho *et al*., 2012). Investigations on post-release survival of mature and lively tope caught with automatic demersal longlines in the Great Australian Bight showed a high resilience to capture, precautious handling and release (Rogers *et al*., 2017).

10.4 Commercial catch composition

Tope is one of the main elasmobranch species caught by the Azorean bottom longline fleet (Morato *et al*., 2003) and was reported in 29% of the trips, representing up to 2% of the total catch landed along the studied period (Figure 10.3) (Santos *et al.* 2018 WD).

10.5 Commercial catch and effort data

Standardized CPUE series for tope from the Azorean bottom longline fleet (1990–2017) are shown in Figure 10.4 (see Table.10.4 in ICES, 2020; Santos *et al.* 2020 WD), with data no longer available from 2018 onwards. The trends from the nominal and standardized index differed substantially; indeed, the nominal CPUE oscillated over time, with peaks in 1999, 2000 and 2017; while the standardized index gave a more stable trend since 1994. According to Ortiz (2017), it is not necessary that the nominal and standardized trends follow the same trend.

10.6 Fishery-independent information

10.6.1 Availability of survey data

Although several fishery-independent surveys operate in the stock area, data are limited for most of these. Analyses of catch data need to be undertaken with care, as tope is a relatively large-bodied species (up to 200 cm L_T in the NE Atlantic), and adults are strong swimmers that forage both in pelagic and demersal waters. Tope are not sampled effectively in beam trawl surveys (because of low gear selectivity). They are caught occasionally in GOV trawl and other (high-headline) otter trawl surveys in the North Sea and westerly waters, though survey data generally include a large number of zero hauls.

The discontinued UK (England and Wales) Q4 IBTS survey in the Celtic Seas ecoregion recorded small numbers of tope, which were tagged and released where possible (ICES, 2008). UK surveys in this area generally caught larger tope at the southern entrance to St George's Channel, and in 2011 several juveniles were caught in the Irish Sea.

Southern and western IBTS surveys may cover a large part of the stock range, and more detailed and updated analyses of these data are required.

The Western waters beam-trawl survey in the English Channel and Celtic Sea did not catch any tope (Silva *et al*., 2020 WD) which is known to occur in the area. However, tope occurs higher up in the water column and is rarely captured by beam trawls.

Data from the Azorean demersal spring bottom longline survey (ARQDAÇO(P)-Q1) were examined by Santos *et al.* (2020), where tope was frequently observed during 1995–2018.

10.6.2 Trends in survey abundance

Updated data for five trawl surveys were examined by WGEF, as summarised below.

IBTS-Q1: Data for the IBTS-Q1 in the North Sea showed a low abundance (and biomass) across countries over the time-series examined (1992–2020), with this survey excluded from further analysis.

IBTS-Q3: The mean CPUE (numbers and biomass) were calculated for the IBTS-Q3 in the North Sea IBTS for the years 1992–2020, with updated estimates provided in 2021 for the whole times series. During this period, there were large differences in abundance and biomass in earlier years compared to recent years (Figure 10.5). The frequency of occurrence for the years 1992–2016 has increased since 2002 (Figure 10.6), but such investigations are needed for the most recent years.

More detailed investigations of IBTS-Q3 data on DATRAS were undertaken by WGEF in 2017 in terms of the length and spatial distribution by nations (Figure 10.7 and 10.8). Length-frequency distributions indicate that data for *Galeorhinus galeus* and *Mustelus* spp. may have been confounded, with this most evident for Danish survey data (See Section 21.6). Data from DAN are included in the present analysis, but it is likely that larger tope have been attributed to *Mustelus* in some years, and so until further analyses of these data are undertaken, the temporal trends in catch rates are not based on a complete data set. Further analyses on the quality of these data are required.

Furthermore, WGEF note that the apparent 'peak' in tope in 1992 in driven by a single large catch at one station (*RV* Thalassa in 35F1, haul number 15 with CPUE of 182 ind/hr). Further examination of these data are required.

IGFS-WIBTS-Q4: Abundance and biomass estimates were calculated for all individuals for the time series 2005–2020 (Figure 10.9) and shows an increasing trend from 2012, with a slight decrease in 2017 and 2018, and a peak in 2020. This survey usually catches small numbers of tope, although one haul (40E2, Division 6.a) in 2006 yielded 59 specimens (Figure 10.9). The peak in 2020 relates to larger specimens (>80 cm total length) being caught in one single haul (33E3, 16 min tow, Division 7.a). Most tope caught are now tagged and released. Survey indices for the whole time series were updated with new estimates provided in 2019. The values have differed from the previous survey index as values are now scaled to the survey area rather than the ecoregion.

EVHOE-WIBTS-Q4: Swept area biomass estimates were calculated for total and exploitable biomass (individuals ≥50 cm total length) for the time series 1997–2020 (Figure 10.10) and fluctuate without trend. Abundance estimates were calculated for individuals <50 cm total length (Figure 10.10), which show that this GOV survey catches mostly larger specimens. New estimates were calculated using DATRAS contrary to previous estimates presented using national data. This survey did not occur in 2017.

The spatial distribution across the time-series (1997–2014) (Figure 10.4 in ICES, 2016b), showed similar locations reported during UK surveys, with the majority of individuals found at the entrance to St George's Channel and outer Bristol Channel.

ARQDAÇO(P)-Q1: Additional information on the Azorean demersal spring bottom longline survey ARQDAÇO(P)-Q1 on the relative abundance index for 1995–2018 is shown in Figure 10.11 (Santos *et al.*, 2020). However, abundance is highly variable over time, with no consistent trend and, this may relate to the gear used being of low catchability and to the survey sampling design.

WGEF consider that any trend analysis should be viewed with care, due to the low catchability on fishery-independent surveys. Given the low and variable catch rates, WGEF do not consider that catch rates are wholly appropriate for quantitative advice on stock status. The proportion of stations at which tope are captured may be an alternative metric for consideration and could be further investigated for more surveys covering the stock area.

10.6.3 Length distributions

In 2009, data were presented on length distributions found in the Celtic Seas ecoregion during fisheries-independent surveys conducted by England and Ireland in Q4 (Figure 10.7 in ICES, 2016b). Irish surveys recorded 145 tope (2003–2009), of which 110 (76%) were male. English surveys recorded 90 tope (56 (62%) males and 34 (38%) females). These specimens were 40–163 cm L_T. The length–frequency distributions found between the surveys were noticeably different, with more large males found in the Irish survey; 75% of the males were greater than 130 cm. The English surveys had a more evenly distributed length range.

Length distributions of tope caught in various UK surveys in 2004–2009 were analysed in 2016 (see Figure 10.8 in ICES 2016b). In the beam trawl survey (Figure 10.8a in ICES, 2016b), two peaks were observed, at 30–54 cm L_T and 70–84 cm L_T respectively. In the North Sea survey (Figure 10.8b in ICES, 2016b) a wide range (30–164 cm L_T) was observed, with a main peak at 30–44 cm L_T. Wide ranges were also observed in the Celtic Sea survey (44–164 cm L_T; Figure 10.8c in ICES, 2016b) and in the western IBTS survey (70–120 cm L_T; Figure 10.8d in ICES, 2016b).

In the Azorean demersal spring bottom longline survey ARQDAÇO(P)-Q1, records also show a wide length range of 25–185 cm L_T, with fish caught at depths up 650 m during 1995–2018. Smaller fish were caught in higher numbers in shallow waters, with an increase in length range observed in deeper waters while decreasing in abundance (Figure 10.12, Santos *et al.*, 2020).

10.6.3.1 Recreational length distributions

During 2009–2013, a Scottish recreational fishery in the Mull of Galloway recorded sex, length and weight of captured tope. While the number of tope tagged has declined, the number of mature fish of both sexes appears to have disproportionally declined (see Figure 10.11 in ICES, 2020). This area is thought to be a breeding ground for tope (James Thorburn, pers. comm., 2014), so the lack of mature animals is a cause for concern.

10.6.4 Tagging information

A total of 159 tope were tagged and released by CEFAS over the period 1961–2013, predominately in the Irish Sea and Celtic Sea (Figure 10.10 in ICES 2016b; Burt *et al*., 2013). Fish were also tagged in the western English Channel and North Sea but in lower numbers (n = 9). Tope were tagged over a wide length range (41–162 cm L_T), the majority being males, with a male to female sex ratio of 1.5:1. A total of four tope were recaptured, and were, on average, at liberty for 1195 days, with a maximum recorded time at liberty of 2403 days. Over the period individual fish had travelled relatively large distances (112–368 km), and all had moved from one ICES division to another. For example, the fish that was at liberty the longest was released in Cardigan Bay (Division 7.a) in November 2003, was later captured in June 2010 just to the east of the Isle of Wight. It is also noted that a tag from a tope was returned to CEFAS from southern Spain, and although release information could not be located, it is thought it may have been tagged in the 1970s.

Mark and recapture data from 3 tagging programmes around the UK (Scottish Shark Tagging Program, the Glasgow Museum Tagging Program, the UK Shark Tagging Program) are available. From 2,043 tagged tope, 138 recapture records were analysed. Connectivity between UK waters and the Azores, the Canary Islands and the Mediterranean where shown (Thorburn *et al.*, 2019). Site fidelity and annual migrations were also suggested due to the closeness of tope recaptures to tagging sites throughout the year; however, seasonal patterns of movement are thought to be confounded by partial migration behaviour in the species (Thorburn *et al.*, 2019). Only mature individuals were found off the shelf and there is a relationship between maximum distance of recapture and body size in females with larger individuals undertaking the biggest movements into southerly regions, these are assumed to be in relation to parturition. There was no relationship between maximum distance and body size in males (Thorburn *et al.*, 2019). Electronic tag data from 4 tope from Scotland showed extensive summer use of shelf waters, but a movement into oceanic waters over winter months with tope diving to 826 m. PSAT tag track reconstruction showed a male tope moving from Scottish waters, around the North and west of Ireland to Porcupine Seabight. (Thorburn *et al.*, 2019).

The Irish Marine Sportfish Tagging Programme has tagged tope off the Irish coast since 1970. Four fish have been recaptured in the Mediterranean Sea (Inland Fisheries Ireland, pers comm. 2013; Fitzmaurice, 1994; cf. nicematin.com, 29 May 2013, "Le long périple d'un requin hâ, de l'Irlande à la Corse). A tope tagged on 30 July 2001 off Greystones (Ireland) as part of this programme, was caught on 9 May 2013 off Bastia, Corsica (Mediterranean Sea), showing a movement of 3900 km in twelve years. One tope tagged off Ireland was recaptured in May 2018, again off the west of Ireland, after 9046 days.

An ongoing tagging project of the German Thünen-Institute of Sea Fisheries (HTTP – Helgoland Tope Tagging Project) has been tagging tope in the southern North Sea (German Bight) around Helgoland Island during annual aggregations of adult sharks in the summer months. As of June

2021, 14 tope have been tagged with Wildlifecomputers MiniPAT pop-up satellite archival tags and conventional tags. Preliminary results showed overwintering of the tope in the western English Channel and partial migration into oceanic habitats of the Northeast Atlantic, including long-distance, southward migrations towards the western part of the Strait of Gibraltar and as far south as Madeira. Tope that migrated into more oceanic areas exhibited extensive diurnal vertical migratory behaviour, with a clear association between vertical migrations to mesopelagic habitat features (deep scattering layers), presumably related to feeding (Schaber *et al*., in prep).

Long-distance migrations of tope from the Northeast Atlantic to the Mediterranean Sea have also been reported by Colloca *et al*. (2019), with two females tagged and released in the Irish Sea being recaptured by Sicilian artisanal fishers using trammel nets. One tope tagged off Luce Bay (West Scotland) in June 2009 was recaptured at a depth of 35 m off Talbot Bank (south-west coast of Sicily) in November 2014, after 1967 days. The second female tope at 153 cm total length tagged off Carlingford Bay (East Ireland) in June 2015, was recaptured at ca. 30 cm depth off Selinunte harbour (South Sicily) in April 2017, after 648 days.

10.7 Life-history information

Much biological information is available for tope in European seas and elsewhere in the world, which are summarized in the stock annex (ICES, 2009).

A genetic study (Chabot and Allen, 2009) on the eastern Pacific population including comparisons with samples from Australia, South and North America and UK, showed that there is little to no gene flow between these populations, indicating a lack of mixing. A Northeast Atlantic and Mediterranean genetic study showed gene flow throughout the region but did observe unique haplotypes in some areas, with outlying genotypes observed in the Mediterranean (Thorburn, in prep). Further genetic assessment is recommended to explore connectivity with the Mediterranean.

The following relationships and ratios were calculated by Séret and Blaison (2010):

$L_T = 0.0119\ W^{2.7745}$ (n = 10; length range of 60–140 cm L_T; weight in g);
Live weight / eviscerated weight = 1.28 (s.d. 0.05);
Live weight / dressed weight (eviscerated, headed, skinned) = 2.81 (s.d. 0.13);
Smallest mature male = 110 cm L_T, smallest mature female 130 cm L_T, fitting with the ranges 120–135 and 134–140 cm L_T observed for other populations.

Additional data from French surveys were presented by Ramonet *et al.* (2012 WD).

The length-weight relationship from tope sampled on UK (E&W) surveys (Silva *et al.*, 2013) was used to convert individual numbers at length to biomass when assessing the North Sea IBTS survey index (Q1 and Q3).

$L_T = 0.0038\ W^{3.0331}$ (n = 43; length range of 39–155 cm L_T; weight in g)

10.7.1 Parturition and nursery grounds

Pups (24–45 cm L_T) are caught occasionally in groundfish surveys, and such data might be able to assist in the preliminary identification of general pupping and/or nursery areas (see Figure 10.5 of ICES, 2007). Most of the pup records in UK surveys are from the southern North Sea (Division 4.c), though they have also been recorded in the northern Bristol Channel (Division 7.f). The updated locations of pups caught in fisheries-independent surveys across the ICES region could usefully be collated in the near future.

Recent study suggests the maximum depth associated with tope may be related to their body size, with specimens under 50 cm L_T being found in waters less than 50 m deep, suggesting small juvenile tope will be restricted to specific areas (Thorburn *et al.*, 2019). A combination of angler data and survey data showed areas where small tope (26–46 cm L_T) were found in the Southern North Sea, the Severn estuary, Cardigan bay and Liverpool bay (Figure 10.13; Thorburn *et al.*, 2019).

The lack of more precise data on the location of pupping and nursery grounds, and their importance to the stock, precludes spatial management for this species at the present time.

10.8 Exploratory assessment models

Various assessment methods have been developed and applied to the South Australian tope stock (e.g. Punt and Walker, 1998; Punt *et al.*, 2000; Xiao and Walker, 2000).

A preliminary capture-recapture model was developed in 2015 using data from the Irish Marine Sportfish Tagging Programme (Bal *et al.*, 2015 WD). This approach was re-applied as an exploratory assessment by WGEF in 2016 including additional Irish tagging records from 2014 and 2015. The approach, results and a discussion of the current state of the model are summarized in the WGEF 2020 report (Figures 10.12–10.17 in ICES, 2020).

10.9 Stock assessment

Catch data (see Section 10.3) and survey data (see Section 10.6) are currently too limited to allow for a quantitative stock assessment of NE Atlantic tope. In 2021, tope was still treated as a Category 5 stock, with advice based on recent estimated landings.

Whilst not used in quantitative advice, WGEF note that available survey trends indicate that catch numbers have been relatively stable or variable in recent years.

10.10 Quality of the assessment

The low catchability of tope in current surveys can lead to variability in catch rates. Trawl surveys are not designed to capture larger pelagic species like tope, and therefore survey catches may not accurately represent population size.

Current surveys do cover a large part of the stock area in northern European waters, but data for other areas are unavailable. The spatial and bathymetric distribution of tope may be influenced by the availability of pelagic prey, which may lead to further variability in catch rates in surveys.

In the absence of any other data sources, surveys with high headline trawls may be the most appropriate species-specific data currently available.

10.11 Reference points

No reference points have been proposed for this stock.

10.12 Conservation considerations

According to the latest IUCN Red List Assessments, tope is listed as Vulnerable in Europe (McCully *et al.*, 2015) and in the Mediterranean (McCully *et al.*, 2016), though listed globally as Critically Endangered (Walker *et al.*, 2020).

Tope have been added to Appendix II of the Convention of Migratory Species of Wild Animals (CMS) during the 13th Conference of Parties in February 2020 (CMS, 2020).

10.13 Management considerations

Tope is considered highly vulnerable to overexploitation, as this species has low population productivity, relatively low fecundity and a protracted reproductive cycle. Unmanaged targeted fisheries elsewhere in the world have resulted in stock collapse (e.g. off California and South America).

Tope is an important target species in recreational fisheries; though there are insufficient data to examine the relative economic importance of tope in the recreational angling sector, this may be high in some regions.

Tope is, or has been, a targeted species elsewhere in the world, including Australia/New Zealand, South America and California. Evidence from these fisheries (see stock annex and references cited therein) suggests that any targeted fisheries would need to be managed conservatively, exerting a low level of exploitation.

Australian fisheries managers have used a combination of a legal minimum and maximum lengths, legal minimum and maximum gillnet mesh sizes, closed seasons and closed nursery areas. These measures may have less utility in the ICES area as tope is taken here mainly in mixed fisheries.

Following the publication of the GFCM (General Fisheries Commission for the Mediterranean) Report of the Workshop on Stock Assessment of selected species of Elasmobranchs in the GFCM area in 2011, WGEF believes that collaboration should continue between ICES and the GFCM. This will encourage the sharing of information and aid the better understanding of elasmobranch fisheries in the Mediterranean, where WGEF data for this region are often lacking.

10.14 References

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Table 10.1. Tope in the Northeast Atlantic. Reported species-specific landings (tonnes) for the period 1975–2004. These data are considered underestimates as some tope are landed under generic landings categories, and species-specific landings data are not available for the Mediterranean Sea and are limited for Northwest African waters.

ICES Area and Nation	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
ICES Division 3.a, 4																					
Denmark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
France	na	na	na	32	22	na	na	26	26	13	31	13	14	18	12	17	16	10	11	12	8
Netherlands																					
Sweden	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UK (E&W)	na	na	na	na	na	na	na	8	10	31	36	94	28	22	18	14	21	15	15	19	25
UK (Scotland)																-	-	-	-	-	-
Subtotal	0	0	0	32	22	0	0	34	36	44	67	107	42	40	30	31	37	25	26	31	33
ICES Subarea 6–7																					
France	na	na	na	522	2076	na	na	988	1580	346	339	1141	491	621	407	357	391	235	240	235	265
Ireland	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Netherlands																					
Spain	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Spain (Basque country)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UK (E&W)	na	na	na	na	na	na	na	63	51	28	23	21	21	21	55	45	47	53	48	49	38
UK (Scotland)																					
Subtotal				522	2076	0	0	1051	1631	374	362	1162	512	642	462	402	438	288	288	284	303
ICES Subarea 8																					
France	na	na	na	na	237	na	na	na	63	119	52	103	97	66	39	34	38	34	40	54	44
Spain	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Spain (Basque country)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UK (E&W)	-	-	-	+	+	+	+	+	+	+	+	1									0
UK Scotland																					
Subtotal				0	237	0	0	0	63	119	52	104	97	66	39	34	38	34	40	54	44

ICES Area and Nation	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
ICES Subarea 9																					
Spain	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Subtotal																					
ICES Subarea 10																					
Portugal	18	na	na	24	15	51	77	42	24	29	24	24	24	34	23	56	81	80	115	116	124
Subtotal	18			24	15	51	77	42	24	29	24	24	24	34	23	56	81	80	115	116	124
Other/Unknown																					
France	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UK (E&W)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
CECAF area																					
Portugal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL LANDINGS	**18**	**0**	**0**	**578**	**2350**	**51**	**77**	**1127**	**1754**	**567**	**505**	**1397**	**675**	**782**	**554**	**523**	**593**	**427**	**469**	**485**	**504**

Table 10.1. (continued). Tope in the Northeast Atlantic. Reported species-specific landings (tonnes) for the period 1975–2004. These data are considered underestimates as some tope are landed under generic landings categories, and species-specific landings data are not available for the Mediterranean Sea and are limited for Northwest African waters.

ICES Area and Nation	1996	1997	1998	1999	2000	2001	2002	2003	2004
ICES Division 3.a, 4									
Denmark	-	.	.	3	8	4	5	5	5
France	11	5	11		11	11	6	6	3
Netherlands									
Sweden	-	.	.	.	.	.	.	.	.
UK (E&W)	14	22	12	14	13	10	13	11	8
UK (Scotland)	-	.	.	.	.	.	.	.	.
Subtotal	25	27	23	17	32	25	24	22	16
ICES Subareas 6–7									
France	314	409	312		368	394	324	284	209
Ireland	na	na	na	na	na	4	1	6	4
Netherlands		.	.	.	.	.	.	.	.
Spain	na	na	na	na	na	+	242	3	na
Spain (Basque country)	-	.	.	.	.	+	+	3	15
UK (E&W)	39	34	41	62	98	72	60	55	65
UK (Scotland)									
Subtotal	353	443	353	62	466	470	627	351	293
ICES Subarea 8									
France	78	40	46	+	71	58	49	60	16
Spain	na	na	na	na	na	9	13	10	na
Spain (Basque country)	-	.	.	.	.	9	6	10	10
UK (E&W)	0	0	0	0		1		3	8
UK Scotland									
Subtotal	78	40	46	0	71	77	68	83	34

ICES Area and Nation	1996	1997	1998	1999	2000	2001	2002	2003	2004
ICES Subarea 9									
Spain	na	na	na	na	na	na	na	na	76
Subtotal									
ICES Subarea 10									
Portugal	80	104	128	129	142	82	77	69	51
Subtotal	80	104	128	129	142	82	77	69	51
Other/Unknown									
France	-	.	.	386	.	2	.	.	.
CECAF area									
Portugal	-	.	.	.	2	1	2	98	na
TOTAL LANDINGS	**536**	**615**	**551**	**593**	**713**	**656**	**798**	**622**	**394**

Table 10.2. Tope in the Northeast Atlantic. ICES estimates of tope landings (tonnes) by area 2005–2020 following WKSHARK2 (ICES, 2016a). Blank = no data reported; 0.0 < 0.1 tonnes.

Fishing Area	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
27.2	0.0	0.0	0.0	0.0		0.0	0.0		0.0		0.0			0.0	0.1	0.1
27.3	1.1	1.3	0.0	0.1		1.0	1.0			1.0	0.4	0.1	0.8	0.2	0.7	0.9
27.4	24.2	26.8	15.6	13.2	9.5	9.2	15.5	6.8	6.4	5.6	6.3	9.2	16.2	6.5	3.3	3.2
27.5b	0.0	0.0	0.5	0.1	0.0	0.0			0.0	0.0	0.0	0.0	0.0			0.0
27.6	3.4	4.0	6.7	5.6	8.0	1.3	0.6	0.7	1.2	1.1	6.2	0.5	0.7	0.2	0.2	0.4
27.7	417.8	445.8	366.7	359.9	348.6	311.1	262.6	277.8	279.5	245.5	301.2	233.8	267.5	302.3	253.4	207.0
27.8	113.1	110.9	102.9	123.4	145.8	80.0	85.1	54.6	60.9	52.8	64.5	90.8	67.1	79.6	82.5	68.7
27.9	37.9	54.0	47.3	48.2	72.6	59.7	53.9	45.0	48.8	54.4	51.1	34.2	37.2	23.4	29.8	37.6
27.10	44.7	45.2	42.5	46.6	33.9	41.3	43.6	47.4	45.7	65.4	71.0	84.9	69.8	41.4	27.0	21.4
27.12			0.0				0.0			0.0	0.0					
27.14							0.0	0.0								
27/(unspecified, incl. BIL94B)	0.2	0.2	0.0	0.0		0.1	0.1	0.0		0.0						
34*	5.0	10.7	3.2	11.1	5.5	28.4	8.0	5.3	2.4	3.6	0.0	0.3	0.8	2.9	2.9	1.0
37*/BIL95	20.3	16.3	15.6	12.8	25.9	32.4	41.2	28.4	38.4	33.0						
Total	**667.7**	**715.2**	**601.3**	**621.1**	**649.9**	**564.4**	**511.5**	**466.1**	**483.3**	**462.4**	**500.8**	**453.7**	**460.2**	**456.7**	**399.9**	**340.2**

*** Landings data from areas 34 and 37 are incomplete and not based on all nations fishing in those areas.**

Table 10.3. Tope in the Northeast Atlantic. ICES species-specific estimates of tope landings (tonnes) 2005–2020 following WKSHARK2 (ICES, 2016a). Blank = no data reported; 0.0 < 0.1 tonnes.

Nation	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Belgium												0.1	0.0	0.0	0.0	0.0
Denmark	7.0	6.0	2.0	3.0	2.0	2.0	3.0	1.0		3.0	1.4	0.9	2.2	1.8	1.2	1.6
France	347.8	383.2	301.9	365.1	353.8	319.7	291.4	282.5	308.9	261.1	349.8	302.7	312.9	355.8	319.6	257.6
Germany													0.4		0.0	0.1
Ireland	5.5	6.8	2.6	2.1	2.9	3.1	0.6	0.3								
Netherlands						2.1	17.7	24.8	11.2	11.4	5.8	8.2	18.7	11.6	0.5	0.4
Norway						0.1	0.2		0.0		0.0			0.0	0.1	0.1
Portugal	44.7	45.2	42.5	46.6	33.9	41.3	43.5	47.4	45.7	65.4	71.0	85.2	70.8	44.3	30.0	22.5
Spain	181.7	181.8	202.9	163.1	234.0	179.4	138.1	94.0	100.3	101.1	55.7	36.8	41.3	30.5	32.9	44.3
Sweden	0.1	0.3	0.0	0.1												
UK	80.8	91.9	49.4	41.1	23.3	16.8	17.0	16.1	17.1	20.4	17.0	19.8	13.8	12.6	15.6	13.6
Total	**667.7**	**715.2**	**601.3**	**621.1**	**649.9**	**564.4**	**511.5**	**466.1**	**483.3**	**462.4**	**500.8**	**453.7**	**460.2**	**456.7**	**399.9**	**340.2**

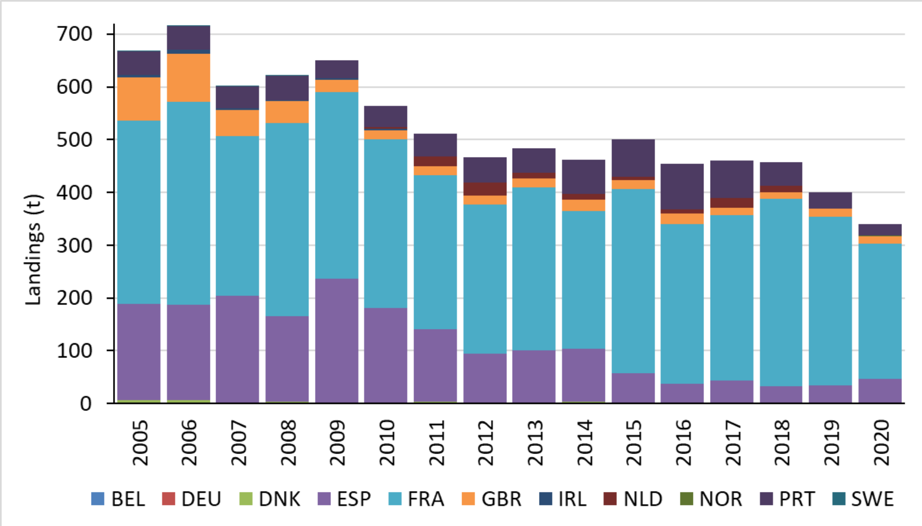

Figure 10.1. Tope in the Northeast Atlantic. ICES species-specific estimated landings by country for 2005–2020.

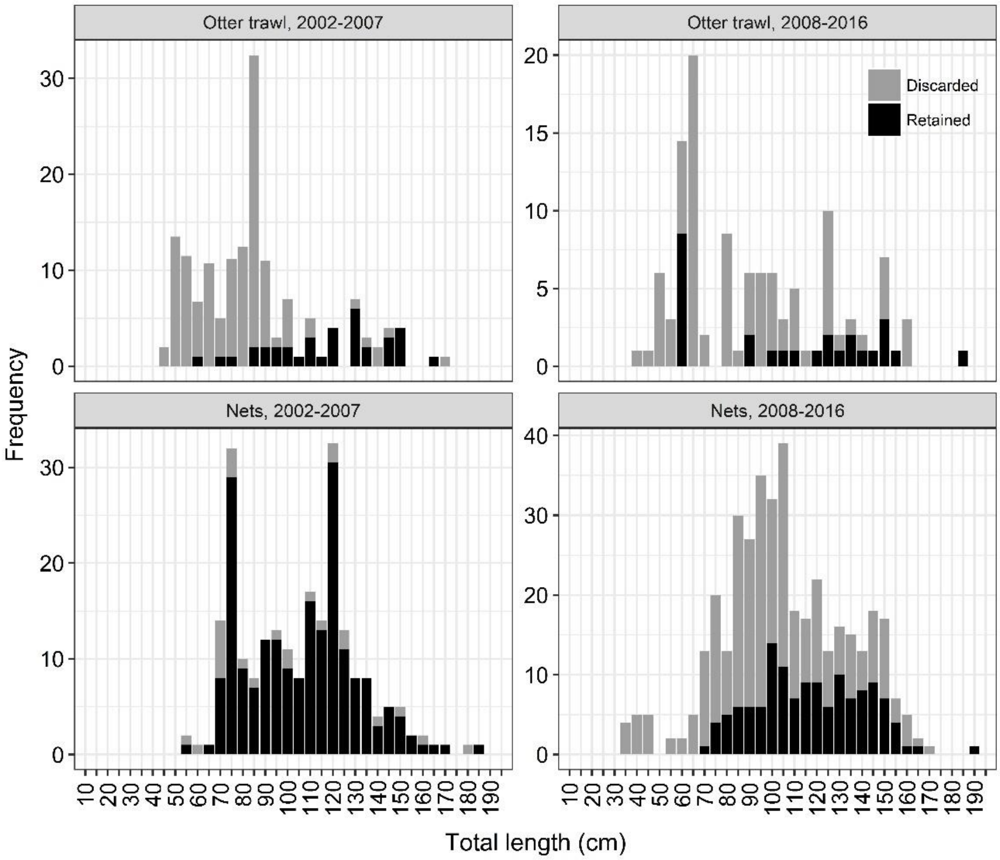

Figure 10.2. Tope in the Northeast Atlantic. Length–frequency of discarded and retained tope *Galeorhinus galeus* (5 cm length classes) caught by otter trawl and gill nets during the periods 2002–2007 and 2008–2016, as recorded in the Cefas observer programme. Source: Silva and Ellis (2019).

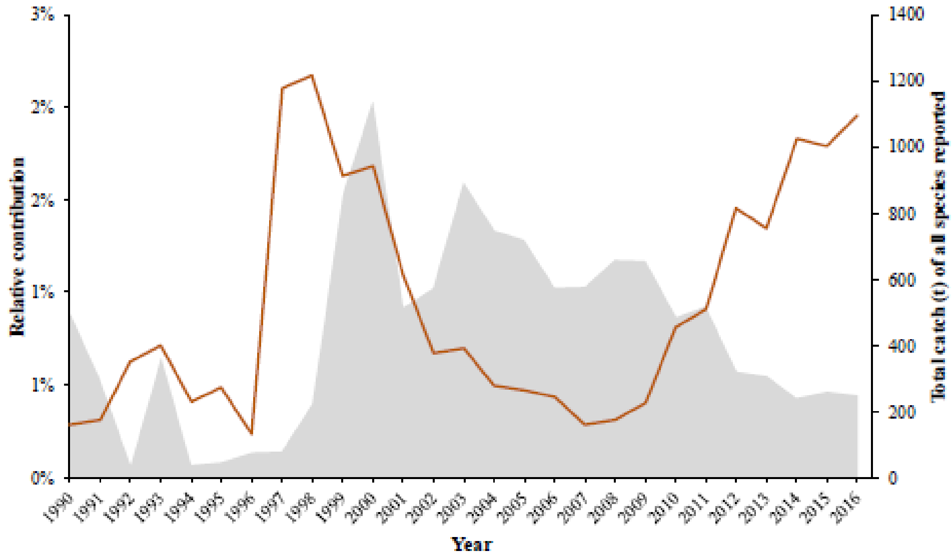

Figure 10.3. Tope in the Northeast Atlantic. Total catch of all species (■) and relative contribution of tope *Galeorhinus galeus* to all species (—) landed by the Azorean bottom longline fleet and sampled by the DCF inquiries.

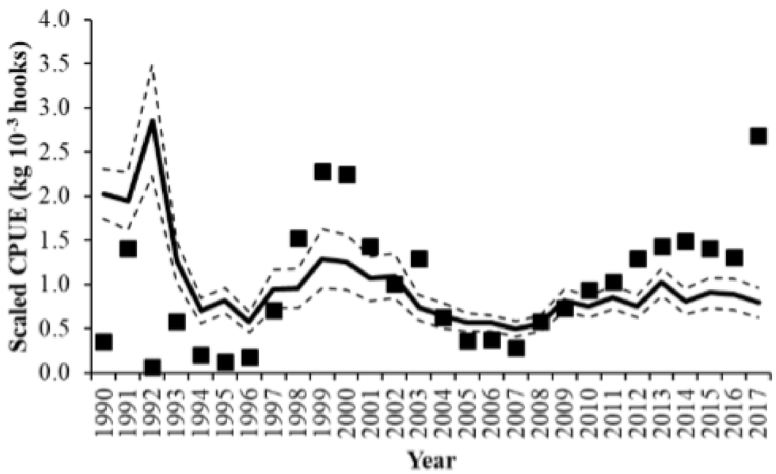

Figure 10.4. Tope in the Northeast Atlantic. Nominal (■) and standardized (—) CPUE (kg 10^{-3} hooks) for tope *Galeorhinus galeus* from the Azorean bottom longline fishery, 1990–2017. Dotted lines represent 95% confidence intervals for the standardized CPUE.

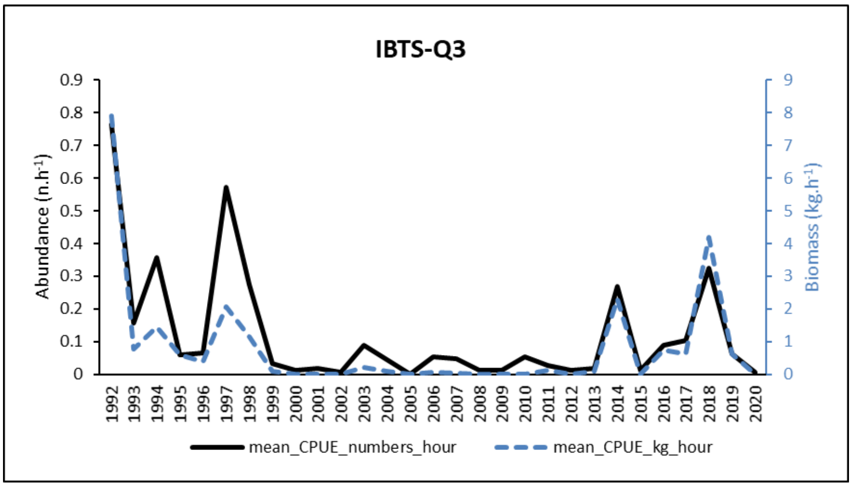

Figure 10.5. Tope in the Northeast Atlantic. Mean catch rate in terms of numbers (n.h^{-1}) and biomass (kg.h^{-1}) during the IBTS-Q3 of the North Sea (1992–2020). Note: The large catch in 1992 is largely due to a large catch reported in one haul, and these data should be verified. Some catches of tope are considered to have been reported as *Mustelus* on DATRAS, consequently this time-series does not provide a robust abundance trend.

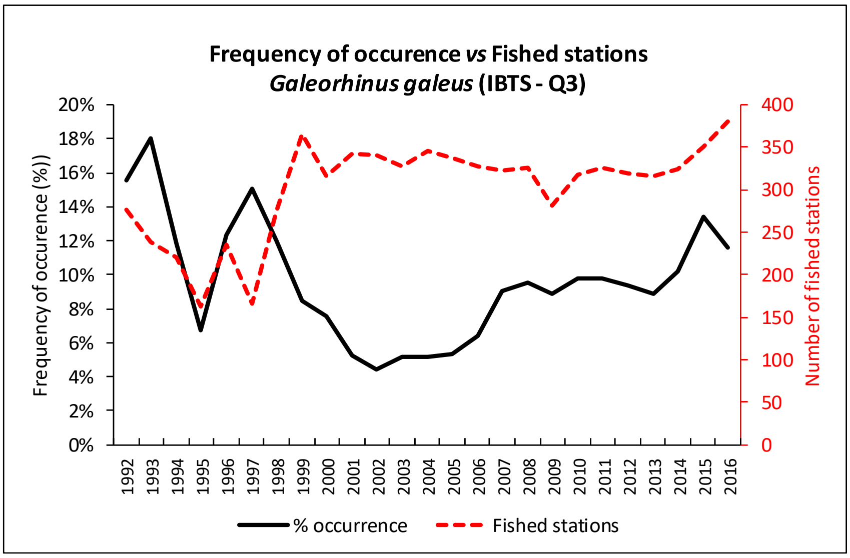

Figure 10.6. Tope in the Northeast Atlantic. Frequency of occurrence and number of fished stations in the IBTS-Q3 of the North Sea (1992–2016).

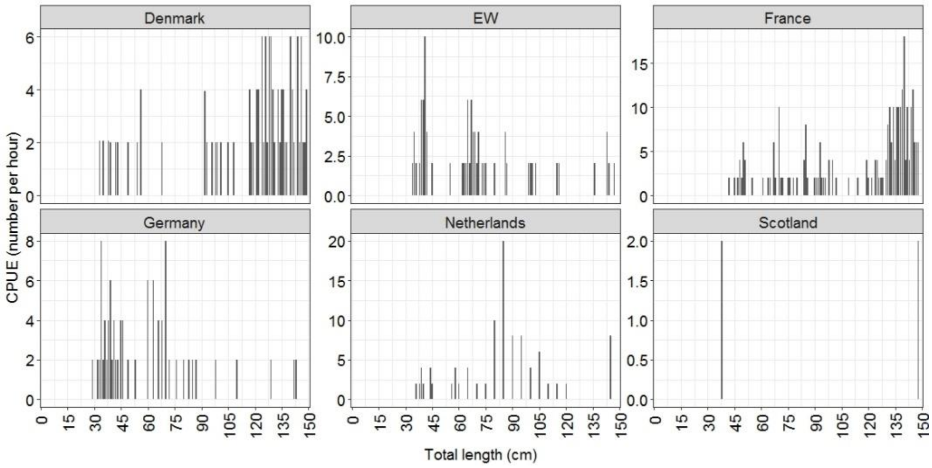

Figure 10.7. Tope in the Northeast Atlantic. Length-frequency distribution of tope by country in the IBTS-Q3 of the North Sea (1992–2016).

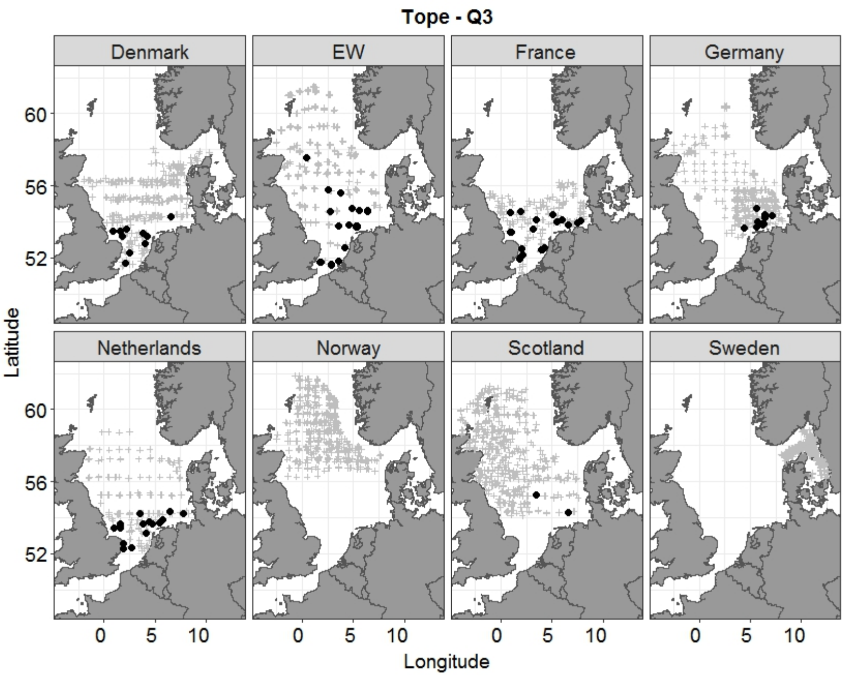

Figure 10.8. Tope in the Northeast Atlantic. Spatial distribution of tope by country in the IBTS-Q3 of the North Sea (1992–2016) (black dots = positive hauls; grey dots = negative hauls).

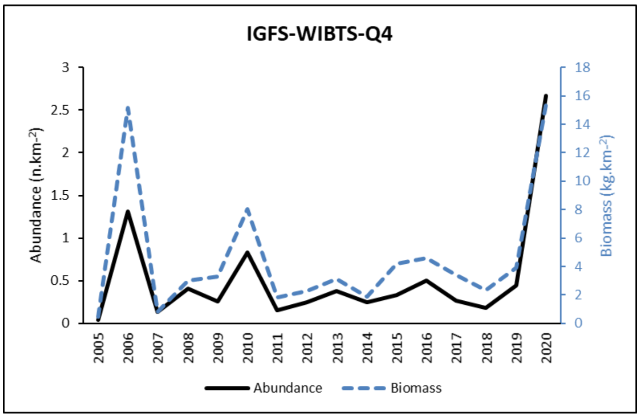

Figure 10.9. Tope in the Northeast Atlantic. Mean catch rate for in terms of abundance (n.km^{-2}) and biomass (kg.km^{-2}) for all individuals during the Irish Ground Fish Survey (IGFS-WIBTS-Q4) 2005–2020.

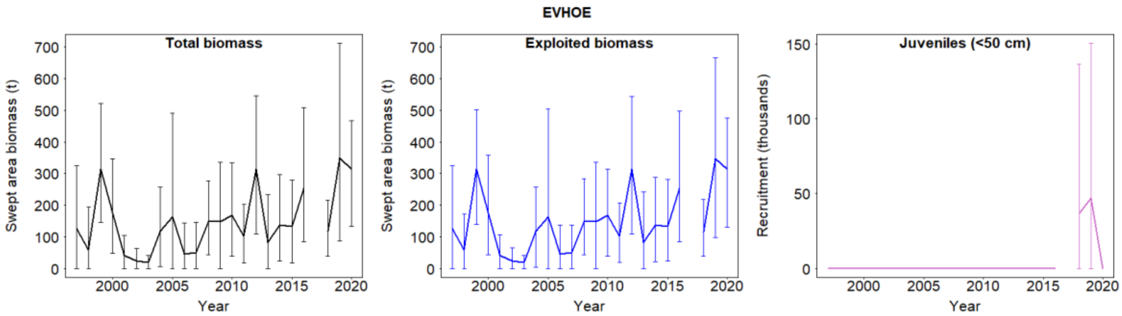

Figure 10.10. Tope in the Northeast Atlantic. Swept area biomass for total (t, all individuals) and exploitable biomass (t, individuals ≥50 cm total length) and, abundance in terms of numbers of juvenile fish (thousands, individuals <50 cm total length) during the EHVOE-WIBTS-Q4 (1997–2020). Associated confidence intervals (95% CI) calculated using bootstrap. Updated results in 2021 for whole time series.

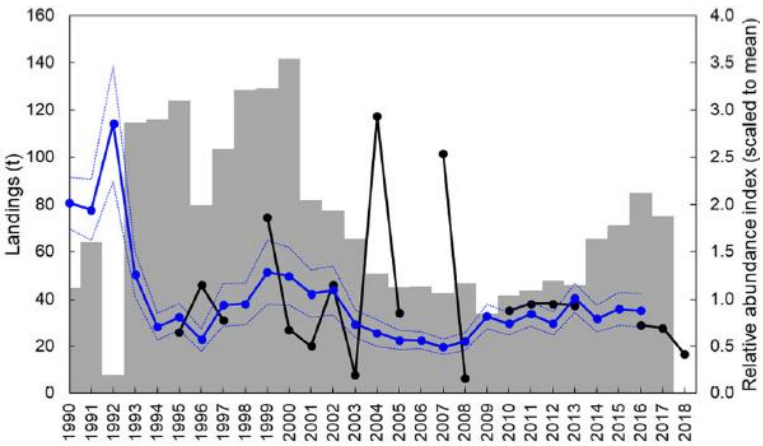

Figure 10.11. Tope in the Northeast Atlantic. Adapted from Santos *et al.* (2020). Landings (bars) and relative abundance index from the Azorean demersal spring bottom longline survey (black colour) and derived from commercial catch and effort (standardized CPUE) data (blue colour) in the Azores archipelago. Dotted lines represent 95% confidence intervals for the standardized CPUE. Note: Historical landings may differ from data in Table 10.1–10.3 so for ICES landings estimates used in advice please refer to Table 10.2 and 10.3.

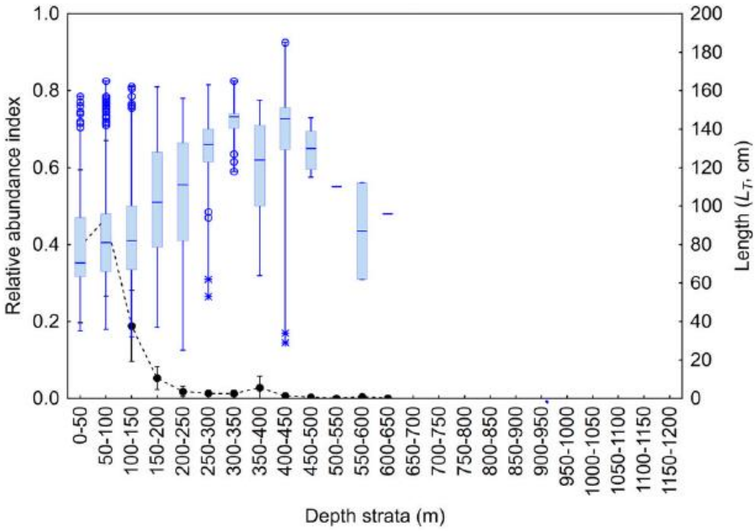

Figure 10.12. Tope in the Northeast Atlantic. Adapted from Santos *et al*. (2020). Relative abundance index (mean ± 0.95 confidence interval) and boxplot of length (L_T, cm) by stratum from the Azorean demersal spring bottom longline survey (1995–2018). Boxes show the quartiles (25–75%), horizontal lines inside each box show the median, and the limits are shown with whiskers. Empty-circle symbols identify outliers and asterisks are extreme outliers.

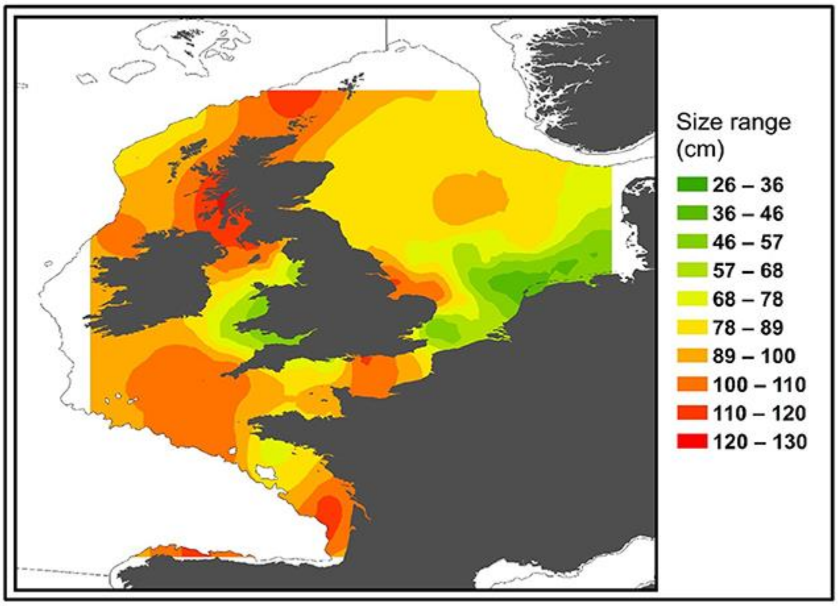

Figure 10.13. Tope in the Northeast Atlantic. Adapted from Thorburn *et al*. (2019). Distribution of all immature tope (max length = 130 cm L_T) based on mark and recapture and International Bottom Trawl Survey (IBTS) data sets. Colour represents smallest sized (based on L_T) animal predicted to occur in that area.

11 Thresher sharks in the Northeast Atlantic and Mediterranean Sea

11.1 Stock distribution

Two species of thresher occur in the ICES area: common thresher, *Alopias vulpinus* and bigeye thresher, *A. superciliosus.* Of these species, *A. vulpinus* is the main species encountered on the continental shelf of the ICES area.

There is little information on the stock identity of these species, which have a near circumglobal distribution in tropical and temperate waters. WGEF assumes there to be a single stock of *A. vulpinus* in the NE Atlantic and Mediterranean Sea, with this stock extending into the CECAF area. The presence of a nursery ground in the Alboran Sea provides the rationale for including the Mediterranean Sea within the stock area. Further information on stock identity is given in the Stock Annex drafted in 2009 (ICES, 2009). This stock annex requires future revision in particular as a consequence of landings data revision carried out in recent years by WGEF.

11.2 The fishery

11.2.1 History of the fishery

There are no target fisheries for thresher sharks in the NE Atlantic. Both species are a bycatch in longline fisheries for tuna and swordfish, and would have been taken in earlier pelagic drift net fisheries. Common thresher is an occasional bycatch in gillnet fisheries. Fisheries data for the ICES area are limited and unreliable. It is likely that some commercial data for the two species are confounded.

In the Mediterranean Sea, where the two thresher sharks species occur, there are no fisheries targeting either of these species. In this area the two species are bycatches in various fisheries, including the Moroccan driftnet fishery in the southwest Mediterranean. Both species are also caught in industrial and semi-industrial longline fisheries and artisanal gillnet fisheries operating in the area.

11.2.2 The fishery in 2020

No new information.

11.2.3 ICES Advice applicable

ICES advice for thresher sharks is given in every 4 years, and the first to be provided was in 2015, stating that "*ICES advises that when the precautionary approach is applied for common thresher shark Alopias vulpinus and bigeye thresher shark Alopias superciliosus in the Northeast Atlantic, fishing mortality should be minimized and no targeted fisheries should be permitted. This advice is valid for 2016 to 2019"*. The latest advice provided by ICES for this stock was in 2019 stating that "*ICES advises that when the precautionary approach is applied, there should be zero catch in each of the years 2020–2023."*

11.2.4 Management applicable

Since 2009, the EU regulations regarding thresher sharks are in the annual TAC regulations in the section on the ICCAT convention area and stipulates that *thresher sharks* should not be fished, retained on board or transhipped (see Council regulation 2021/92 of 28 January 2021).

Council Regulation No. 1185/2003 prohibits the removal of shark fins of these species, and subsequent discarding of the body. This regulation is binding on EC vessels in all waters and non-EC vessels in Community waters.

11.3 Catch data

11.3.1 Landings

Landings of thresher sharks are reported irregularly and are variable; from 4–198 t in the North and Eastern Atlantic and Mediterranean Sea from 1997 to 2019 (ICCAT and national data; tables 11.1–11.2). There can be large inter-annual variation in reported landings, as well as differences in values reported to ICCAT (tables 11.1–11.2) and ICES (Table 11.3). Further studies to review landings data for thresher sharks are required and should be included in the proposed joint meetings with the ICCAT shark subgroup. Compared to pre-2020 reports, landings presented this year (tables 11.1–11.3) were restricted to landings reported in the Northeast Atlantic and Mediterranean Sea, excluding other areas. Landings now considered are therefore lower than previously.

An unknown proportion of landings is reported as generic 'sharks'. Historically, the main European countries reporting landings of thresher sharks were Portugal, Spain and France, although the large quantities reported by Portugal to ICCAT in 2006 and 2007 require a further verification. In the most recent years, only France has maintained high levels of landings of thresher sharks (almost 99% of landings in 2020).

As well as being caught and landed from fisheries for tuna and tuna-like species, thresher sharks are also a bycatch in continental shelf fisheries in the ICES area, including subareas 4, 6–9.

11.3.2 Discards

Limited data are available.

11.3.3 Quality of catch data

Thresher sharks have not been reported consistently, either at species-specific or generic level. There are also some discrepancies between some data sources. Landings of thresher shark in coastal waters are most likely to represent *A. vulpinus*, but some of these landings may also be reported as 'sharks nei'.

11.3.4 Discard survival

There is limited information on discard survival from European fisheries, but there have been several studies elsewhere in the world. Braccini *et al.* (2012) found that about two thirds of thresher shark captured in gillnets were dead, even with a short soak time, although this was based on a small sample size. Moderate to high levels of mortality have been reported in pelagic longline fisheries, with most studies indicating that about half of the thresher sharks captured are in poor condition or dead (see Ellis *et al.*, 2017 and references therein). Immediate mortality of bigeye thresher shark (*A. superciliosus*) caught in swordfish longline fisheries in the Pacific has been estimated between 7% (Aalbers, 2021) and 25% (Musyl *et al.*, 2011).

11.4 Commercial catch composition

Length–frequency distributions for *A. vulpinus* were collected under the Data Collection Regulation (DCR) programme by observers on board French vessels (see ICES, 2015). Given the potential problems of how thresher sharks are measured (standard length, fork length, total length), improved standardisation of length-based information is required.

11.5 Commercial catch and effort data

Limited data on landing and effort are available for the ICES area. ICES and ICCAT should cooperate to collate and interpret commercial catch data from high seas and shelf fisheries.

11.6 Fishery-independent surveys

No fishery-independent data are available for the NE Atlantic.

11.7 Life-history information

Various aspects of the life history, including conversion factors, and nursery grounds for these species are included in the Stock Annex.

Alopias vulpinus

There have been a few recent published studies on *A. vulpinus*. Cartamil *et al.* (2016) and Kinney *et al.* (2020) examined the movements of *A. vulpinus* along the western coast of the USA and Mexico; Natanson *et al.* (2016) provided revised growth curves for *A. vulpinus*, in the NW Atlantic; and Finotto *et al.* (2016) commented on the occurrence of *A. vulpinus* in the northern Adriatic Sea.

Relevant information from these studies should be reviewed for future work by WGEF.

11.7.1 Movements and migrations

The "Alop" Project tagged two specimens in the Gulf of Lions. The behaviour of one female (135 cm L_T) was recorded for 200 days. Horizontal movements within a restricted area of the Gulf of Lions were observed; the female stayed in coastal shelf areas from July to September, moving to deeper waters afterwards, probably as a response to the seasonal drop in sea surface temperature. Another specimen (120 cm L_T) stayed mostly at depths of 10–20 m with occasional dives to 800 m.

Cao *et al.* (2012) provided data for *A. superciliosus* and *A. vulpinus* around the Marshall Islands (Pacific, West Central), where they occurred at depths of 240–360 m and 160–240 m, temperatures of 10–16°C and 18–20°C and salinities of 34.5–34.7 and 34.5–34.8, respectively.

A. superciliosus

Nakano *et al.* (2003) conducted an acoustic telemetry study to identify the short-term horizontal and vertical movement patterns of two immature female *A. superciliosus* in the eastern tropical Pacific Ocean (summer 1996). Distinct crepuscular vertical migrations were observed; specimens often occurring at 200–500 m depth during the day and at 80–130 m depth at night, with slow ascents and relatively rapid descents during the night, the deepest dive being 723 m. The estimate of the mean swimming speed over the ground ranged from 1.32–2.02 km h^{-1}.

Weng and Block (2004) studied diel vertical migration patterns of two *A. superciliosus* that were caught and tagged with pop-up satellite archival tags in the Gulf of Mexico and near Hawaii. Both showed strong diel movement patterns, spending most of the day below the thermocline (waters of 10°C at 300–500 m and 400–500 m) and occurring in warmer (> 20°C) surface mixed layers above the thermocline (10–50 m) at night.

Carlson and Gulak (2012) provided results from a tagging programme with archival tags deployed on *A. superciliosus*. One specimen exhibited a diurnal vertical diving behaviour, spending most of their time between 25 and 50 m depth in waters between 20 and 22°C while the other dove down to 528 m. Deeper dives occurred more often during the day, and by night they tended to stay above the thermocline.

In the tropical northeast Atlantic fifteen bigeye threshers were tagged with pop-up satellite archival tags (PSATs) in 2012 and 2014, with successful transmissions received from 12 tags for a total of 907 tracking days. Marked diel vertical movements were recorded on all specimens, with most of the daytime spent in deeper colder water and nighttime spent in warmer water closer to the surface. The operating depth of the pelagic longline gear was measured and it was concluded that there is spatial overlap between the fishery and the habitat particularly during the night and overlap is higher for juveniles (Coelho *et al.*, 2014).

A. vulpinus

Kinney *et al.* (2020) studied the seasonal movements of 25 tagged common thresher sharks off the west coast of North America. They provided evidence for movements driven by the biological state (body size, sex) and environmental drivers, with younger individuals mostly remaining in an identified nursery area: the Southern California Bight, while larger individuals frequently moved out of the bay in spring and winter.

Based on catch data and data collected by onboard observers along the eastern coast of the US, Kneebone *et al.* (2020) found evidence for seasonal changes in distribution, with individuals found at more northern latitudes in the summer. Young of the year were almost exclusively found in continental shelf waters north of 33.5°N, mostly in shallow waters, and seemed to display reduced migrations compared to older individuals. No evidence for differences in movements of males and females was found.

11.7.2 Nursery grounds

Further information on potential nursery areas is given in the Stock Annex.

A. superciliosus

Nursery areas for *A. superciliosus* occur off the southwestern Iberian Peninsula and Strait of Gibraltar (Moreno and Moron, 1992).

A. vulpinus

Juvenile *A. vulpinus* are known to occur in the English Channel and southern North Sea (Ellis, 2004). The capture of newborn individuals in northern Adriatic Sea supports the presence of a nursery in this area (Finotto *et al*. 2016).

11.7.3 Diet

Both *A. vulpinus* and *A. superciliosus* feed mostly on small pelagic fish, including mackerel and clupeids, as well as squid and octopus (e.g. Preti *et al*. 2012).

11.8 Exploratory assessments

Both *A. vulpinus* and *A. superciliosus* were included in a Productivity-Susceptibility Analysis (PSA) for the pelagic fish assemblage (ICCAT, 2009). However, the lack of reliable landing data, and absence of fishery-independent data hampered the assessment of the two thresher stocks. A bycatch per unit effort (BPUE) was derived for bigeye thresher shark caught by the Portuguese longline fleet between 2008 and 2016 (ICCAT, 2020).

Along the west coast of North America, *A. vulpinus* is assumed to be a single, well-mixed stock. This assumption is supported by genetics, tagging data, and seasonal movements. This stock was assessed with Stock Synthesis modelling platform (v3.24U). The results obtained included the estimation of management quantities for eight fishing fleets operating in USA and Mexico waters (Teo *et al*., 2018).

A Bayesian population modelling tool integrating separable virtual population analysis, per-recruit models and age-structured demographic analysis was developed for the *A. superciliosus* population in an area subset of the western North Pacific. The results from the risk analysis revealed that only low levels of fishing pressure (10% of the current fishing pressure) over a wide range of ages could maintain a relatively low risk of population decline for bigeye threshers. Sensitivity testing indicated that the model is robust to prior specification (Tsai *et al*., 2019). The results from the analysis of sequences of mitochondrial DNA showed no significant differences between populations of *A. superciliosus* from southern Atlantic and the Indian Ocean further suggesting the existence of a high dispersal of this species (Morales *et al*., 2018).

11.9 Stock assessment

In 2019, *A. vulpinus* and *A. superciliosus* were both assessed under the ICES framework for category 6 (ICES, 2012). In accordance to this, ICES considered that for stocks without information on abundance or exploitation, as is the case of these two stocks, a precautionary reduction of catches should be implemented unless there is ancillary information clearly indicating that the current level of exploitation is appropriate for the stock.

11.10 Quality of assessments

At the Northeast Atlantic level, there is no stock assessment for common thresher or bigeye thresher. However, in 2012, ICCAT conducted an Ecological Risk Assessments for elasmobranchs to evaluate the biological productivity of these stocks and a susceptibility analysis to assess their propensity to capture and mortality in pelagic longline fisheries (ICCAT, 2011).

Historically, landing data for the entire stock area is uncertain for both common thresher and bigeye thresher. Some historical commercial catch-per-unit-effort data are available for parts of the stock area, but data for the two species may be confounded. It is unclear as to how representative CPUE data would be for informing on trends in the two stocks' abundance.

Species-specific landings are required, and future quantitative assessments should be undertaken in collaboration with ICCAT.

11.11 Reference points

No reference points have been proposed for these stocks.

11.12 Conservation considerations

In 2015, a revision of the Red List for European Marine Fishes classified both *Alopias vulpinus* and *A. superciliosus* as Endangered (Nieto *et al.*, 2015).

All three species of thresher sharks were listed in Appendix II of CITES on 02/01/2017 (Entry into effect delayed by 12 months, i.e. until 04 October 2017). The species covered are the bigeye thresher *A. superciliosus*, and the look-alike species common thresher *A. vulpinus* and pelagic thresher *A. pelagicus*. This listing went into effect in October 2017.

11.13 Management considerations

There is limited knowledge of the stock structure or the exploitation status of these two species of thresher shark occurring in the NE Atlantic.

Liu *et al.* (1998) considered *Alopias* spp. to be particularly vulnerable to overexploitation; requiring a close monitoring because of their high vulnerability resulting from low fecundity and relatively high age of sexual maturity.

The 2008 Ecological risk assessments (ERA) undertaken by ICCAT for eleven pelagic sharks indicated that the bigeye thresher has the lowest productivity and highest vulnerability with a productivity rate of 0.010. In this study common thresher was ranked 10th, with a productivity rate of 0.141 (ICCAT, 2009). The ERA was then updated and expanded notably with the addition of five species and the consideration of interactions between stocks and fisheries in 2012. This new ERA led to similar conclusion to the previous one, with bigeye thresher appearing as the most vulnerable species whereas common thresher gets an intermediate rank within the 20 stocks considered (Cortés *et al.*, 2015).

In 2009, the International Commission for the Conservation of Atlantic Tuna (ICCAT, 2009) recommended the following:

1. "CPCs (The Contracting Parties, Cooperating non-Contracting Parties, Entities or Fishing Entities) shall prohibit, retaining on board, transhipping, landing, storing, selling, or offering for sale any part or whole carcass of bigeye thresher sharks (*Alopias superciliosus*) in any fishery with exception of a Mexican small-scale coastal fishery with a catch of less than 110 fish;
2. CPCs shall require vessels flying their flag to promptly release unharmed, to the extent practicable, bigeye thresher sharks when brought along side for taking on board the vessel;
3. CPCs should strongly endeavour to ensure that vessels flying their flag do not undertake a directed fishery for species of thresher sharks of the genus *Alopias* spp.;
4. CPCs shall require the collection and submission of Task I and Task II data for *Alopias* spp. other than *A. superciliosus* in accordance with ICCAT data reporting requirements. The number of discards and releases of *A. superciliosus* must be recorded with indication of status (dead or alive) and reported to ICCAT in accordance with ICCAT data reporting requirements;
5. CPCs shall, where possible, implement research on thresher sharks of the species *Alopias* spp. in the Convention area in order to identify potential nursery areas. Based on this

research, CPCs shall consider time and area closures and other measures, as appropriate."

Some of these recommendations appear to have been acted on by the EU (see Section 11.2.4). In 2010, the General Fisheries Commission for the Mediterranean (GFCM) adopted ICCAT's thresher shark Recommendation (banning retention of bigeye threshers *A. superciliosus*).

11.14 References

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Table 11.1. Thresher sharks in the Northeast Atlantic and Mediterranean Sea. Reported landings of thresher sharks (1997 to 2018; ICCAT data, accessed June 2021). An unknown proportion of thresher sharks are reported in combined sharks. Areas are ADRI: Adriatic Sea; AZOR: Azores; IONIA: Ionian Sea; MDRA: Madeira; MEDI: Mediterranean Sea; NE: Northeast Atlantic; and S.SIC: Strait of Sicily.

Flag	Area	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Algerie	MEDI																		
China (Taipei)	NE															0.2	2	1.2	0.1
Curaçao	NE																		
El Salvador	NE																		
Denmark	NE																		
Spain	MEDI	3.5	7.2	6.7	9.2	9	25.3	0.4	1.1			2.5	2.7	0.2					
	NE	190.3	167.4	49.6	42.1	109	48.6	26.1	63.2			43.9	70.4	77.7					
France	MEDI											5.7	9.6	5.7	1.6	1	0.5	1.4	
	NE								23.3	18.5		31.2		26	25.3	40.6	6.7	30.9	
Ireland	NE				0.1			0	0.1		0.3								
Italy	MEDI											7.4	5.5	13.9	4.1			21.3	
	ADRI																		2
	IONIA																		0
	S.SIC																		0.7
Malta	MEDI	0.1	0.7	0.2	1.4							0.2	0.1	0.3	0.1	0.1			
Portugal	AZOR									8.1	11.9	16.4	7.5	21.3	0.6				
	MDRA									0.1	1	3.1		0.1					
	MEDI						0.5				0.1								
	NE		0	1.3	1.8	1.6	21.2	17.5	20.9		94.5	79	43.8	43.1	15		0.6	1.4	
UK	NE										0	1.1	0.8	0.7	1.6	1.3	0.8	1.1	2
Guatemala	NE																		
Korea	NE																	0.3	
Liberia	NE																		
Mauritania	NE																		
Panama	NE																		
Russian Fed.																			
Senegal	NE												2.5	9					
TOTAL		193.8	175.3	57.8	54.6	119.6	95.7	44.1	108.6	26.7	107.8	190.5	142.9	198	48.5	43.3	10.6	57.6	4.9

Table 11.1 cont'. Thresher sharks in the Northeast Atlantic and Mediterranean Sea. Reported landings of thresher sharks (1997 to 2019; ICCAT data, accessed June 2021). An unknown proportion of thresher sharks are reported in combined sharks. Areas are ADRI: Adriatic Sea; AZOR: Azores; IONIA: Ionian Sea; MDRA: Madeira; MEDI: Mediterranean Sea; NE: Northeast Atlantic; and S.SIC: Strait of Sicily.

Flag	Area	2015	2016	2017	2018	2019
Algeria	MEDI	0.4			0.9	18.7
China (Taipei)	NE	0.8	1	0.2	0.4	0.2
Curaçao	NE			0		
El Salvador	NE			0		
Denmark	NE					0.4
Spain	MEDI					
	NE			0.1		
France	MEDI	2.5				0.6
	NE	38.8	35.2	55.9	44.6	47.2
Ireland	NE					
Italy	MEDI		0.5	2.5	1.2	1.5
	ADRI					
	IONIA					
	S.SIC					
Malta	MEDI					
Portugal	AZOR					
	MDRA					
	MEDI					
	NE					
UK	NE	2.5	3		0.6	0.6
Guatemala	NE			0		
Korea	NE	0.5				
Liberia	NE				0.5	
Mauritania	NE		13.2			
Panama	NE			0		
Russian Fed.	NE					0
Senegal	NE					
TOTAL		45.6	52.9	58.8	48.3	69.1

Table 11.2. Thresher sharks in the Northeast Atlantic and Mediterranean Sea. Reported landings of thresher shark by species and nation for EU and UK (ICCAT data, accessed June 2021). An unknown proportion of thresher sharks are reported in combined sharks. ALV = *Alopias vulpinus*, BTH = *Alopias superciliosus*, THR = *Alopias* spp.

Year	Denmark	Spain			France			Ireland		Italy	Malta		Portugal			United Kingdom
	ALV	THR	BTH	ALV	THR	BTH	ALV	THR	ALV	ALV	BTH	ALV	THR	BTH	ALV	THR
1997		25.2	148.1	30.1								0.1				
1998		26.9	103.8	43.9								0.7		0.0		
1999		56.3										0.2			1.3	
2000		22.6	21.0	7.7					0.1			1.4	1.8			
2001		61.6	35.4	21.0									1.6			
2002		24.5	38.0	11.4											21.7	
2003		1.3	17.5	7.7				0.0							17.5	
2004		10.8	37.4	16.1			23.3	0.1							20.9	
2005							18.5								8.1	
2006									0.3						107.5	0.0
2007			32.1	14.3			36.9			7.4		0.2	2.8	0.0	95.7	1.1
2008		73.1					9.6			5.5		0.1		0.6	50.7	0.8
2009			50.1	27.7			31.7			13.9		0.3			64.4	0.7
2010							27.0			4.1		0.1		0.7	15.0	1.6
2011					0.2	0.1	41.3					0.1				1.3
2012							7.2								0.6	0.8
2013							32.3			21.3	0.0			0.1	1.3	1.1
2014										2.7						2.0
2015				0			41.3			0						2.5
2016							35.2			0.5						3.0
2017			0.1				55.9			2.5						
2018							44.6			1.2						0.6
2019	0.4						47.8			1.5						0.6
TOTAL	0.4	302.4	473.9	180.0	0.2	0.1	453.0	0.1	0.4	60.6	0.0	3.2	6.2	1.4	404.7	16.3

Table 11.3. Thresher sharks in the Northeast Atlantic and Mediterranean Sea (FAO areas 27 and 37). Reported landings of thresher shark (*Alopias* spp.) for the period 2005–2020 (Data following the 2016–2021 data calls). Data are considered preliminary and more dedicated studies to refine a time series of thresher shark landings is required.

Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Denmark													<0.1		0.3	0.2
France	33.1	36.2	42.1	26.5	38.7	28.0	51.3	34.0	33.6	43.1	38.8	70.3	55.9	44.6	47.2	62.4
Ireland		0.3														
Netherlands			0.1									<0.1				
Portugal	49.4	78.9	54.8	22.9	27.2	12.7	3.3	0.6	1.3	0.2	0.9	0.6	1.0	0.3	0.2	0.5
Spain	4.2	10.6	32.2	97.0	35.0	0.2	<0.1	0.1								
UK	0.4	<0.1	1.1	0.8	0.7	1.6	1.3	0.8	1.1	2.0	2.5	3.0		0.6	0.6	0.7
Total	87.0	126.0	130.2	147.2	101.6	42.6	56.0	35.5	36.0	45.3	42.2	73.9	56.8	45.6	48.2	63.8

12 Other pelagic sharks in the Northeast Atlantic

12.1 Ecosystem description and stock boundaries

In addition to the pelagic species discussed previously (sections 6–11), several other pelagic sharks and rays occur in the ICES area (Table 12.1). Many of these taxa, including hammerhead sharks (*Sphyrna* spp.) and requiem sharks (*Carcharhinus* spp.), are tropical to warm temperate species, and often coastal pelagic species.

There are limited data with which to examine the stock structure of these species, and the ICES area would only be the northern extremes of their Northeast Atlantic distribution range. Other species, including long-fin mako, silky shark and oceanic white-tip are truly oceanic and likely to have either North Atlantic or Atlantic stocks, although data to confirm the exact stocks boundaries are limited. These species are found mostly in the southern parts of the ICES areas (subareas 9–10), though some may occasionally range further north into the Bay of Biscay (Subarea 8). Some of these species also occur in the Mediterranean Sea.

In October 2011, a whale shark *Rhincodon typus* was reported from southern Portugal (Rodrigues *et al.*, 2012), and the northern limits of this species also extend to the Azores (Afonso *et al.*, 2014).

12.1.1 Taxonomic changes

A recent treatise on batoids (Last *et al.*, 2016) considers all eight species of manta ray and devil ray to be in a single genus *Mobula,* with two of these species (giant manta ray *Mobula birostris* and giant devil ray *Mobula mobular* shown as occurring in the southernmost part of the ICES area (Subarea 9). Both these species also occur around the Azores (Subarea 10; Santos *et al.*, 1997), with Sobral and Afonso (2014) also indicating that the Chilean devil ray *Mobula tarapacana* also occurred as far north as the Azores.

12.2 The fishery

12.2.1 History of the fishery

Pelagic sharks and also some ray species are an incidental bycatch in tuna and billfish fisheries (mainly longline, but also purse-seine) and a very occasional bycatch in other pelagic fisheries. Some, like hammerhead and requiem sharks, may constitute a noticeable component of the bycatch and were traditionally landed, whilst others are only recorded sporadically (e.g. white shark, tiger shark and *Mobula* spp.). Although some of these species are an important bycatch in high seas fisheries (e.g. silky shark and oceanic whitetip), others are taken in continental shelf waters of the ICES area (e.g. various requiem sharks and hammerhead sharks).

12.2.2 The fishery in 2020

No new information is available.

12.2.3 ICES advice applicable

ICES does not provide advice on these stocks.

12.2.4 Management applicable

EC Regulation No. 1185/2003 (updated by EU Regulation No 605/2013) prohibits the removal of shark fins of these species, and subsequent discarding of the body. This regulation is binding on EC vessels in all waters and non-EC vessels in Community waters.

Article 10 of Council Regulation (EU) 2019/1241 states the prohibition of for Union vessels to fish for, retain on board, tranship, land, store, sell, display or offer for sale the species listed in Annex I or species for which fishing is prohibited under other Union legal acts, and includes the following pelagic elasmobranchs relevant here:

- White shark *Carcharodon carcharias* in all waters;
- Mobulid rays (*Mobula* spp. and *Manta* spp.) in all waters

Article 20 of Council Regulation (EU) 2021/92 lists prohibited species which, if caught accidentally, should not be harmed and should be released promptly. It is prohibited for EU vessels to fish for, to retain on board, to tranship or to land species listed in this Article, which include the following pelagic elasmobranchs:

- Whale shark *Rhincodon typus* in all waters.

Article 27 of Council Regulation (EU) 2021/92 also lists prohibited species in relation to fisheries operating in the ICCAT Convention area. The species prohibited include hammerhead sharks (Family Sphyrnidae, except for *Sphyrna tiburo*), oceanic whitetip *Carcharhinus longimanus*, silky shark *Carcharhinus falciformis*, and bigeye thresher *Alopias superciliosus*.

The listings on Article 27 of Council Regulation (EU) 2021/92 are in support of ICCAT recommendations that Contracting Parties "prohibit, retaining on board, transhipping, landing, storing, selling, or offering for sale any part or whole carcass" of silky shark *Carcharhinus falciformis* (Recommendation 2011–08), oceanic whitetip shark *Carcharhinus longimanus* (Recommendation 2010–07), bigeye thresher *Alopias superciliosus* and all hammerhead sharks (Family Sphyrnidae, except bonnethead shark *Sphyrna tiburo*) (Recommendation 2010–08). In addition, "It shall be prohibited to undertake a directed fishery for species of thresher sharks of the *Alopias* genus".

12.3 Catch data

12.3.1 Landings

No reliable estimates of landings or catches are available for these species, as many nations that land various species of pelagic sharks have often recorded them under generic landings categories. There can also be differences in the data reported to ICES, ICCAT and FAO, and so the most accurate data sources need to be verified.

Historical species-specific landings reported to ICES were summarised in earlier WGEF reports. Data reported to ICCAT are given in Table 12.2, with the data presented here referring to ICCAT Sampling Areas (SAs) BIL94B and BIL94C in the North-east Atlantic (i.e. including the ICES area and extending southwards into the central eastern Atlantic (to 5°N), but excluding the Mediterranean Sea. Spain and Portugal are the main European nations reporting 'other pelagic shark species' from the Northeast Atlantic.

Some of these data are known coding errors (e.g. some of the reported landings of 'tiger shark' by the Netherlands), and other nominal landings data that are likely coding errors include the reported landings of white shark.

Catch data are provided for the Spanish longline swordfish fisheries in the NE Atlantic in 1997–1999 (Castro *et al*., 2000; Mejuto *et al.*, 2002). They show that 99% of the bycatch of offshore longline fisheries consisted of pelagic sharks (Table 12.3), although 87% was blue shark.

Available landings data from FAO FishStat for the NE Atlantic (Table 12.4) are considered underestimates, due to inconsistent reporting and use of generic categories. However, this is the only database to report landings of devil ray (17 tonnes by Spain 2004–2011).

More dedicated effort to compile an appropriate time-series of landings is required.

12.3.2 Discards

No data are available. Some species are usually retained, but other species, such as the pelagic stingray, are usually discarded. There are now EU regulations to prohibit the retention of some species, and these species should now be discarded.

12.3.3 Quality of catch data

Catch data are of poor quality (see above), except for some occasional studies of the Spanish Atlantic swordfish longline fishery (e.g. Castro *et al*., 2000; Mejuto *et al*., 2002) and of Portuguese pelagic longline fishery in the Atlantic Ocean (e.g. Santos *et al.*, 2014). Biological data are not collected under the Data Collection Regulations, although some generic biological data are available (see Section 12.7). Species-specific identification in the field is problematic for some genera (e.g. *Carcharhinus* and *Sphyrna*).

Methods developed to identify shark species from fins (Sebastian *et al*., 2008; Holmes *et al*., 2009) could be used to gather data on species retained in IUU fisheries on the high seas, this information should aid in management and conservation.

12.3.4 Discard survival

There have been several studies on the at-vessel mortality of pelagic sharks in longline fisheries, although more limited data are available for purse-seine fisheries. These studies were reviewed by Ellis *et al.* (2017).

12.4 Commercial catch composition

Data on the species and length composition of these sharks are limited.

12.5 Commercial catch and effort data

No CPUE data are available to WGEF for these pelagic sharks in the ICES area. ICCAT is the main source for appropriate catch and effort data for pelagic sharks, with data also available for the Northwest Atlantic (e.g. Cramer and Adams, 1998; Cramer *et al*., 1998; Cramer, 1999).

12.6 Fishery-independent data

No fishery-independent data are available for these species.

12.7 Life-history information

The overall biology of several species has been reviewed, including white shark (Bruce, 2008), silky shark (Bonfil, 2008), oceanic whitetip (Bonfil *et al.*, 2008; Young & Carson, 2020) and pelagic stingray (Neer, 2008). Other biological information is available in a range of sources (e.g. Branstetter, 1987, 1990; Stevens and Lyle, 1989; Shungo *et al.*, 2003; Piercy *et al.*, 2007). A summary of the main biological parameters is given in Table 12.5.

Little information is available on nursery or pupping grounds. Silky shark is thought to use the outer continental shelf as primary nursery ground (Springer, 1967; Yokota and Lessa, 2006), and young oceanic whitetip have been found offshore along the Southeast coast of the USA, suggesting offshore nurseries over the continental shelf (Seki *et al.*, 1998). Scalloped hammerhead nurseries are usually in shallow coastal waters.

In relation to *M. mobular*, Fortuna *et al.* (2014) estimated the size of the population of *M. mobular* in the Adriatic Sea as 3255 adults, from 60 field observations and available biological parameters. It was reported that several hundred specimens of *M. mobular* (estimates varied from 200–500) were caught by fishermen of the Gaza Strip on 27 February 2013.

Given the quantities of reported landings of longfin mako *Isurus paucus* and hammerhead sharks, of which *Sphyrna zygaena* is the main species occurring in the ICES area, further information is provided here for these two species.

12.7.1 Longfin mako *Isurus paucus*

Longfin mako is a pelagic species that is distributed widely in warm-temperate to tropical waters of the Atlantic, Indian and Pacific Oceans. Whilst most records of this species have been from the western Atlantic, including Cuba (Dodrill & Gilmore, 1979; Hueter *et al.*, 2017; Ruiz-Abierno *et al.*, 2021), it also occurs around the Azores, as far north as 44.8°N (Moreno & Moron, 1992; Queiroz *et al.*, 2008; Mucientes *et al.*, 2013) and occasional individuals have also been reported from the Mediterranean Sea (Hemida & Capapé, 2008).

Biological data for this species are limited. Typical of other lamnid sharks, it has a low fecundity (2–8 pups), which are born at about 97–120 cm (Gilmore, 1983; Compagno, 2001). The length at 50% maturity for males and females has been estimated at 215 cm and 230 cm total length, respectively (Ruiz-Abierno *et al.*, 2021). The smallest mature and largest immature females observed in that study were 220 cm and 257 cm, respectively, whilst the smallest mature and largest immature males were 208 cm and 224 cm, respectively (Ruiz-Abierno *et al.*, 2021).

Hueter *et al.* (2017) satellite tagged two individuals, which moved from the Gulf of Mexico into the oceanic waters of the western North Atlantic. These individuals also undertook vertical migrations, moving into surface waters at night, and spent most time at depths shallower than 600 m, with occasional dives into deeper (to 1767 m) waters.

12.7.2 Smooth hammerhead *Sphyrna zygaena*

Smooth hammerhead is the more frequently recorded hammerhead shark occurring in both the ICES area and Mediterranean Sea (Celona & De Maddalena, 2005). Whilst this species has a global distribution, the Atlantic population(s) appears to be distinct to the Indo-Pacific (Miller, 2016). It appears to prefer warm (>23°C) surface waters. In the eastern Atlantic, it is more abundant in the warmer waters west of Africa, though the distribution extends up into Division 9.a (Couto *et al.*, 2018; Santos & Coelho, 2019), with very occasional records as far north as the British Isles (Southall & Sims, 2008).

The biology of the species in the Atlantic is little known, though there are studies from elsewhere in the world (Miller, 2016). Growth parameters for smooth hammerhead caught in the eastern Atlantic have been estimated by Coelho *et al.* (2011), based on 139 specimens of 136–233 cm fork length (L_F). The estimated VBGP were L_{inf} = 272 cm L_F, K = 0.06, t_0 = –9.4 (males) and L_{inf} = 285 cm L_F, K = 0.07, t_0 = –7.3 (females). A subsequent study with increased sample size (n = 304; 126–253 L_F) estimated the growth parameters as L_{inf} = 285 cm L_F, K = 0.09 and L_{inf} = 294 cm L_F, K = 0.09 for males and females, respectively (Rosa *et al.*, 2017).

The length-at-maturity (L50%; based on samples from the Pacific) is estimated at 194 cm L_T and 200 cm L_T for males and females, respectively (Nava Nava & Márquez-Farías, 2014), with higher estimates (L50% = 239.3 cm L_T (females) and 263.7 cm L_T (males)) provided by López-Martínez *et al.* (2020).

The oceanic movements of smooth hammerhead in the Atlantic were described by Santos & Coelho (2018), with neonates and juveniles occurring in shallow, coastal waters, and larger individuals making more oceanic movements (Diemir *et al.*, 2011; Francis, 2016; Santos & Coelho, 2018, 2019). Whilst based on studies in the eastern Pacific, Félix-López *et al.* (2019) suggested that smooth hammerhead displayed philopatric behaviour. The diet of smooth hammerhead has been described for many parts of the geographical range (Smale, 1991; Smale & Cliff, 1998; Gonzalez-Pestana *et al.*, 2017; Dicken *et al.*, 2018; Estupiñán-Montaño *et al.*, 2019).

12.8 Exploratory assessments

No assessments have been made of these stocks in the NE Atlantic. Cortés *et al.* (2010) undertook a level 3 quantitative Ecological Risk Assessment (ERA) for eleven pelagic elasmobranchs (blue shark, shortfin and longfin mako, bigeye and common thresher, oceanic whitetip, silky, porbeagle, scalloped and smooth hammerhead, and pelagic stingray). Of these species, silky shark was found to be high risk (along with shortfin mako and bigeye thresher sharks), and oceanic whitetip and longfin mako sharks were also considered to be highly vulnerable.

McCully *et al*. (2012) undertook a level 2, semi-quantitative ERA for pelagic fish in the Celtic Sea area, and of the 19 species considered (eight of which were elasmobranchs), porbeagle and shortfin mako were found to be at the highest risk in longline and setnet fisheries, followed by common thresher. A comparable analysis examining the pelagic ecosystem for the Northeast Atlantic could usefully be considered.

12.9 Stock assessment

No stock assessments have been undertaken.

12.10 Quality of the assessment

No stock assessments have been undertaken.

12.11 Reference points

No reference points have been proposed for these stocks.

12.12 Conservation considerations

The recent European Red List of European marine fish (Nieto *et al.*, 2015) listed white shark *Carcharodon carcharias* as Critically Endangered, and giant devil ray *Mobula mobular*, oceanic whitetip *Carcharhinus longimanus* and sandbar shark *Carcharhinus plumbeus* as Endangered in European seas. Many other pelagic sharks are listed as Data Deficient in European waters, including silky shark *Carcharhinus falciformis*, blacktip *C. limbatus*, dusky shark *C. obscurus*, tiger shark *Galeocerdo cuvier*, scalloped hammerhead *Sphyrna lewini*, great hammerhead *S. mokarran*, smooth hammerhead *S. zygaena* and longfin mako *Isurus paucus*. Pelagic stingray *Pteroplatytrygon violacea* is listed as Least Concern.

The Convention on the Conservation of Migratory Species of Wild Animals (CMS) lists several elasmobranchs on Appendix I (i.e. Contracting Parties that are a Range State should prohibit the taking of such species) including whale shark *Rhincodon typus*, *Carcharodon carcharias* and *Mobula* spp. These species are also listed on Appendix II of CMS (i.e. species that require international agreements for their conservation and management), with *Isurus paucus*, *Carcharhinus falciformis*, *Carcharhinus obscurus*, *Sphyrna lewini* and *S. mokarran* also listed on Appendix II. In 2020, *Sphyrna zygaena* was also added to Appendix II of CMS.

Carcharodon carcharias, *Rhincodon typus*, *Carcharhinus falciformis*, *C. longimanus*, *Sphyrna lewini*, *S. mokarran*, *S. zygaena* and *Mobula* spp. are also listed on Appendix II of CITES.

12.13 Management considerations

There is a paucity of the fishery data on these species, and this hampers the provision of management advice.

Some of the species considered in this section are included in various conservation initiatives, including CMS and CITES (see above), with some protected in the Mediterranean Sea, through their listing on Appendix II of the Barcelona Convention.

In 2012, a consortium of scientific institutions (AZTI, IEO, IRD and IFREMER) obtained a contract from the EC to review the fishery and biological data on major pelagic sharks and rays. The aim was to identify the gaps that could be filled in the frame of the implementation of the EU shark action plan (EUPOA-Sharks) in order to improve the monitoring of major elasmobranch species caught by both artisanal and industrial fisheries for large pelagic fish in the Atlantic, Indian and Pacific Oceans. The consortium reviewed and prioritised the gaps identified to develop a research programme to fill gaps and to support the formulation of scientific advice for management. The main gaps concerned fishery statistics, which are often not broken down by species, a lack of size–frequency data and regional biological/ecological information. The final report was given to the DG-Mare of the EU in May 2013 (DG-Mare, 2013).

A subsequent project updated this work, providing updated information on the occurrence of pelagic sharks and rays in different fisheries, updated information on data collection and methodological approaches for assessing their status, a critical review of existing Conservation and Management Measures (CMMs) for sharks and their current conservation status, and approaches to improve and/or provide alternative options for conservation and management of sharks. The final report (Coelho *et al.*, 2019) is available at https://publications.europa.eu/en/publication-detail/-/publication/bb27e867-6185-11e9-b6eb-01aa75ed71a1/language-en.

In October 2019, STECF conducted a dedicated expert working group aiming to review the implementation of the shark finning regulation and to assess the impact of the 2009 European Community Action Plan for the Conservation and Management of sharks (CPOA). A review of the fisheries potentially involved in catching sharks and in particular marketing shark fins was conducted by main EU country. This included finning of pelagic sharks such as smooth hammerhead *Sphyrna zygaena* or silky shark *Carcharhinus falciformis* considered to be present on Chinese fins retailers (Fields *et al.*, 2017). The final report provides an overview of progress in the fisheries management of elasmobranch during the 10 years implementation of CPOA and proposes actions for improvements (STECF, EWG 19-17, 2019).

In 2013, the shark species group of ICCAT proposed the framework of a Shark Research and Data Collection Program (SRDCP) to fill up the gaps in our knowledge on pelagic sharks that are responsible for much of the uncertainty in stock assessments, and have caused constraints to the provision of scientific advice. The final report is available at ICCAT website (ICCAT, 2013).

12.14 References

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Table 12.1. Other pelagic sharks in the Northeast Atlantic. Summary of the distribution of pelagic elasmobranchs in the ICES area. Species that are resident or caught frequently in an area are denoted ●, species that may occur as occasional vagrants denoted ⦿ and species that have not been recorded in an area are denoted ○. Adapted from Whitehead *et al.* (1989).

Family	Common name	Scientific name	ICES Subarea			
			7	8	9	Notes
Lamnidae	White shark	*Carcharodon carcharias*	○	⦿	⦿	[1]
	Longfin mako	*Isurus paucus*	○	○	⦿	
Rhincodontidae	Whale shark	*Rhincodon typus*	○	○	⦿	
Carcharhinidae	Bronze whaler	*Carcharinus brachyurus*	○	○	?	
	Spinner shark	*Carcharhinus brevipinna*	○	○	⦿	
	Silky shark	*Carcarhinus falciformis*	○	○	⦿	
	Blacktip shark	*Carcharhinus limbatus*	○	○	⦿	
	Oceanic whitetip	*Carcharhinus longimanus*	○	⦿	⦿	[2]
	Dusky shark	*Carcharhinus obscurus*	○	○	⦿	
	Sandbar shark	*Carcharhinus plumbeus*	○	⦿	⦿	
	Night shark	*Carcharhinus signatus*	○	○	?	
	Tiger shark	*Galeocerdo cuvier*	?	?	⦿	[3]
Sphyrnidae	Scalloped hammerhead	*Sphyrna lewini*	○	○	⦿	
	Great hammerhead	*Sphyrna mokarran*	○	○	?	
	Smooth hammerhead	*Sphyrna zygaena*	⦿	⦿	⦿	
Dasyatidae	Pelagic stingray	*Pteroplatytrygon violacea*	⦿	⦿	⦿	[4]
Mobulidae	Giant devil ray	*Mobula mobular*	⦿	⦿	⦿	[5]
	Giant manta ray	*Mobula birostris*	○	○	⦿	

[1] Three records from the Bay of Biscay; [2] One individual stranded in Swedish waters; [3] Some unconfirmed sightings in northern Europe; [4] Two specimens recorded from the North Sea; [5] Individual specimens reported from the Bay of Biscay (capture) and Celtic Sea (stranding).

Table 12.2. Other pelagic sharks in the Northeast Atlantic. Summary of total reported landings data (1990–2019) as reported to ICCAT (Task 1 Nominal catch data; downloaded 15/06/2021; ICCAT version of 18/12/2020, includes landings and dead discards) for Sampling Areas (SAs) BIL94B and BIL94C in the North-east Atlantic. These data relate to both the ICES area and extend southwards into the central eastern Atlantic (to 5°N). Data for the Mediterranean Sea (BIL95) not included. These data may include coding errors and taxonomic errors.

Scientific name	Code	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Carcharodon carcharias	WSH															
Isurus paucus	LMA					0.1	0.9		1.2	8.2		16.0	38.1	52.6	52.0	47.3
Pseudocarcharias kamoharai	PSK															
Carcharhinus altimus	CCA									0.9						
Carcharhinus brachyurus	BRO															
Carcharhinus brevipinna	CCB															
Carcharhinus falciformis	FAL									10.4	0.3		0.8		0.1	4.3
Carcharhinus galapagensis	CCG															
Carcharhinus limbatus	CCL							0.7	0.1				0.0			
Carcharhinus longimanus	OCS							0.9	0.5	2.4		0.0	3.8	0.1	0.1	
Carcharhinus obscurus	DUS							0.0		0.1						
Carcharhinus plumbeus	CCP															
Carcharhinus signatus	CCS									2.4			0.0			0.1
Galeocerdo cuvier	TIG					0.3			2.7	5.4		12.2	4.7	3.5	2.7	4.7
Rhizoprionodon acutus	RHA	52.0	9.0	7.0	12.0	5.0	5.0	12.0		5.0	10.0	20.0	138.0	11.0	23.0	1.0
Carcharhinidae	RSK	389.0	375.0	1034.0	1016.0	1700.0	955.0	1586.0	239.0	996.9	1056.5	1714.0	1825.7	1058.7	1422.4	1651.0
Sphyrna lewini	SPL									2.6			0.1		0.1	2.2
Sphyrna mokarran	SPK									1.1						
Sphyrna zygaena	SPZ					0.5				2.8		1.6	4.8	1.7	1.1	12.6
Sphyrna spp	SPN	141.7	150.0	151.0	131.0	182.0	129.0	190.1	508.5	483.3	117.0	426.2	1768.2	465.0	361.0	615.7
Sphyrnidae	SPY															
Pelagic Sharks nei	PXX					0.1	0.1	65.7	32.3	33.3	6.2	14.3				
Pteroplatytrygon violacea	PLS															

Scientific name	Code	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Manta birostris	RMB															
Mobula japanica	RMJ															
Mobula mobular	RMM															
Mobula tarapacana	RMT															
Mobulidae	MAN															
TOTAL		530.7	525.0	1185.0	1147.0	1882.9	1085.0	1843.4	784.2	1549.9	1180.0	2184.4	3646.1	1581.8	1839.5	2337.9

Table 12.2 (continued). Other pelagic sharks in the Northeast Atlantic. Summary of total reported landings data (1990–2019) as reported to ICCAT (Task 1 Nominal catch data; downloaded 15/06/2021; ICCAT version of 18/12/2020) for Sampling Areas (SAs) BIL94B and BIL94C in the North-east Atlantic. These data relate to both the ICES area and extend southwards into the central eastern Atlantic (to 5°N). Data for the Mediterranean Sea (BIL95) not included. These data may include coding errors and taxonomic errors.

Scientific name	Code	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Carcharodon carcharias	WSH	5.9						92.0	11.1	24.9	7.0					
Isurus paucus	LMA			40.2	0.4	65.4	39.2	42.8	95.0	95.0	64.8	34.4	42.3	33.2	97.0	80.6
Pseudocarcharias kamoharai	PSK											1.4				
Carcharhinus altimus	CCA															
Carcharhinus brachyurus	BRO				0.5	0.4										
Carcharhinus brevipinna	CCB					0.0										
Carcharhinus falciformis	FAL		0.1	62.7	0.1	22.5	0.0	55.7	0.7	0.0		4.1	0.6	98.9	18.0	27.2
Carcharhinus galapagensis	CCG					1.2										
Carcharhinus limbatus	CCL						4.8	0.2		0.0						
Carcharhinus longimanus	OCS	0.7	0.1	3.8	0.3	22.3	85.4		0.0			0.0	0.0	0.1	0.0	
Carcharhinus obscurus	DUS			0.3		0.0		6.0	0.6	3.0						
Carcharhinus plumbeus	CCP	0.1	0.1			4.3	0.1		0.2	1.2						
Carcharhinus signatus	CCS				0.1		2.0			6581.0						
Galeocerdo cuvier	TIG			2.7	0.2	2.4	0.8	3.3	0.1	0.0						
Rhizoprionodon acutus	RHA	11.0	16.0	5.0		68.0		6.0	3.0							

Scientific name	Code	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Carcharhinidae	RSK	5425.3	1040.6	1714.7	1287.5	375.0	426.2	964.7	8.0	5.8	965.6	1242.7	524.1	145.2	65.6	27.6
Sphyrna lewini	SPL			0.3		12.1	0.3	1.0	0.4			0.1	0.0	6.1	0.1	0.0
Sphyrna mokarran	SPK													1.3	1.3	
Sphyrna zygaena	SPZ	10.9	5.9	2.0		1.3	5.9	153.8	158.1	439.4	0.3	2.3	0.1	1.5	0.4	10.0
Sphyrna spp	SPN	344.1	187.2	291.3	117.7	242.7	70.7	51.1	0.1	0.3	112.5	166.9				
Sphyrnidae	SPY				138.6				0.2				238.7	29.3	35.8	243.2
Pelagic Sharks nei	PXX															
Pteroplatytrygon violacea	PLS											0.0		0.0	0.0	0.0
Manta birostris	RMB													0.2		
Mobula japanica	RMJ													2.1		
Mobula mobular	RMM													4.5	1.4	4.2
Mobula tarapacana	RMT															0.2
Mobulidae	MAN													1.8		
TOTAL		5787.1	1233.9	2117.9	1545.2	749.7	635.6	1370.5	274.4	7150.9	1150.1	1451.9	805.9	324.2	219.6	393.1

Table 12.3. Other pelagic sharks in the Northeast Atlantic. Shark bycatch in the Spanish swordfish longline fisheries of the NE Atlantic. Data from Castro *et al*., 2000 and Mejuto *et al.*, 2002.

Shark bycatches of the Spanish longline swordfish fishery								
Northeast Atlantic	*Carcharhinus* spp.	*Sphyrna* spp.	*Galeocerdo cuvier*	*Isurus paucus*	*Mobula* spp.	Total by-catch	% sharks	% blue shark
1997	148	382	3	8		28 000	99.4	87.5
1998	190	396	5	8	7	26 000	99.4	86.5
1999	99	240	4	18	1	25 000	98.6	87.2

Table 12.4. Other pelagic sharks in the Northeast Atlantic. Reported landings (t) by country for 2000–2018 (Source FAO Fish-Stat 2020) for Atlantic, northeast fishing area. * Data for *Galeocerdo cuvier* are considered to be coding errors

FAO FISHSTAT (2020)																				
Country	**Species**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Portugal	*Sphyrna zygaena*	22	10	21	18	27	43	39	39	32	35	54	0	0	0	2	1	0	0	0
Spain	*Mobula mobular*					1	3	3	2	1	3	4	5	0						
	Sphyrna zygaena			9	88	167	246	117	144	66	85	0	0	0	0	0	0	0	0	0
	Galeocerdo cuvier					2	4	5	3	2	-									
France	*Pteroplatytrygon violacea*													1	0	0	0	0	0	0
Netherlands	**Galeocerdo cuvier*			13	48	48	64	54	38	32	39	0	53	15	0	0	0	0	0	0
TOTAL		22	10	42	154	245	360	218	226	133	162	58	58	16	0	2	1	0	0	0

Table 12.5. Other pelagic sharks in the Northeast Atlantic. Preliminary compilation of life-history information for NE Atlantic sharks.

Species	Distribution Depth range	Max. TL cm	Egg development	Maturity size cm	Age at maturity (years)	Gestation period (months)	Litter size	Size at birth (cm)	Lifespan years	Growth	Trophic level
White shark *Carcharodon carcharias*	Cosmopolitan 0–1280 m	720	Ovoviviparous+ oophagy	372–402	8–10	?	7–14	120–150	36	L∞ = 544 K= 0.065 T0 = –4.40	4.42–4.53
Longfin mako *Isurus paucus*	Cosmopolitan	417	Ovoviviparous	230 F 215 M			2–8	97–120			4.5
Spinner shark *Carcharhinus brevipinna*	Circumtropical 0–100 m	300	Viviparous	176–212	7.8–7.9	10–12	Up to 20	60–80		L∞ = 214 FL K= 0.210 T0 = –1 .94	4.2–4.5
Silky shark *Carcharhinus falciformis*	Circumtropical 0–500 m	350	Viviparous	210–220 M 225 F	6–7 7–9	12	2–15	57–87	25	L∞ = 291/315 K= 0.153 / 0.1 T0 = –2.2 / –3.1	4.4–4.52
Oceanic whitetip *Carcharhinus longimanus*	Cosmopolitan 0–180 m	396	Viviparous	175–189	4–7	10–12	1–15	60–65	22	L∞ = 245 / 285 K= 0.103 / 0.1 T0 = 2.7 / – 3.39	4.16–4.39

Species	Distribution Depth range	Max. TL cm	Egg development	Maturity size cm	Age at maturity (years)	Gestation period (months)	Litter size	Size at birth (cm)	Lifespan years	Growth	Trophic level
Dusky shark *Carcharhinus obscurus*	Circumglobal	420	Viviparous	220–280	14–18	22–24	3–14	70–100	40	L∞ = 349 / 373 K= 0.039/ 0.038 T0 = –7.04/ –6.28	4.42–4.61
Sandbar shark *Carcharhinus plumbeus*	Circumglobal 0–1800 m	250	Viviparous	130–183	13–16	12	1–14	56–75	32	L∞ = 186 FL K= 0.046 T0 = –6.45	4.23–4.49
Night shark *Carcharhinus signatus*	Atlantic 0–600 m	280	Viviparous	185–200	8–10	~12	4–12	60		L∞ = 256 / 265 K= 0.124 / 0.114 T0 = –2.54 / – 2.7	4.44–4.5
Tiger shark *Galeocerdo cuvier*	Circumglobal 0–350 m	740	Ovoviviparous	316–323	8–10	13–16	10–82	51–104	50	L∞ = 388 / 440 K= 0.18 / 0.107 T0 = –1.13 / –2.35	4.54–4.63
Scalloped hammerhead *Sphyrna lewini*	Cosmopolitan 0–512 m	430	Viviparous	140–250	10–15	9–10	13–31	45–50	35	L∞ = 320 / 321 K= 0.249 / 0.222 T0 = –0.41 / – 0.75	4.0–4.21
Great hammerhead *Sphyrna mokarran*	Circumglobal 1–300 m	610	Viviparous	250–292		11	13–42	60–70		L∞ = 264 / 308 (FL) K= 0.16 / 0.11 T0 = -1.99 / -2.86	4.23–4.43
Smooth hammerhead *Sphyrna zygaena*	Circumglobal 0–200 m	500	Viviparous	210–265		10–11	20–50	50–60			4.32–4.5
Pelagic stingray *Pteroplatytrygon violacea*	Cosmopolitan 37–238	160	Ovoviviparous	35–40 DW	2–3	2–4	4–9	15–25 DW	~10	L∞ = 116 DW K= 0.0180	4.36
Gian devilray *Mobula mobular*	NE Atl. + Med. epipelagic	520	Ovoviviparous			25	1	≤ 166 DW			3.71

13 Demersal elasmobranchs in the Barents Sea

13.1 Ecoregion and stock boundaries

The ecology of the Barents Sea ecosystem (ICES Subarea 1, extending into the eastern parts of Subarea 2) has been described comprehensively by Jakobsen and Ozhigin (2012).

Lynghammar *et al*. (2013) reviewed the occurrence of chondrichthyan fish in the Barents Sea ecoregion. The skate species reported to be inhabiting offshore areas of this ecoregion included thorny skate *Amblyraja radiata*, Arctic skate *Amblyraja hyperborea*, round skate *Rajella fyllae*, spinytail skate *Bathyraja spinicauda*, common skate complex (*Dipturus batis* and/or *D. intermedius*, but see Section 26.1), sailray *Rajella lintea*, long-nose skate *Dipturus oxyrinchus,* shagreen ray *Leucoraja fullonica* and thornback ray *Raja clavata* (Andriashev, 1954; Dolgov, 2000; Dolgov *et al.*, 2005a; Wienerroither *et al.*, 2011; Knutsen *et al*., 2017 WD), but few occur at high abundance. All skate species occurring in offshore areas also occur in more coastal areas, with the exception of *A. hyperborea, D. oxyrinchus* and *R. lintea* (Williams *et al.*, 2008). The spatial distribution of chondrichthyan fishes in the Barents Sea, as observed in recent surveys, has been described by Wienerroither *et al*. (2011; 2013).

Stock boundaries are not known for the skates in this area. Neither are the potential movements of species between the coastal and offshore areas. Further investigations are necessary to determine potential migrations or interactions of elasmobranch populations within this ecoregion and adjacent areas.

Amblyraja radiata is the dominant species, comprising 96% by number and about 92% by biomass of skates caught in surveys or as bycatch. The next most abundant species are *A. hyperborea* and *R. fyllae* (3% and 2% by number, respectively), and the remaining species are scarce (Dolgov *et al.*, 2005a; Drevetnyak *et al.*, 2005).

The species composition of skates caught in the Barents Sea differs from those recorded in the Norwegian Deep and northeastern Norwegian Sea (Skjaeraasen and Bergstad, 2000; 2001). Although *A. radiata* is the dominant species in both areas, the proportion of warmer-water species (*B. spinicauda* and *R. lintea*) is lower and the portion of cold-water species (*A. hyperborea*) is higher in the Barents Sea.

In terms of other elasmobranchs, sharks known to occur in the Barents Sea include spurdog (Section 2), velvet belly lanternshark (Section 5), porbeagle shark (Section 6), Greenland shark (Section 24) and, in the southern part of the area, blackmouth catshark (Section 25). One chimaeroid (*Chimaera monstrosa*) also occurs.

13.2 The fishery

13.2.1 History of the fishery

All skate species in the ecoregion may be taken as bycatch in demersal fisheries, but there are at present no fisheries targeting skates in the Barents Sea. Detailed data on catches of skates from the Barents Sea are only available from bycatch records and surveys from 1996–2001 and 1998–2001, respectively (provided by Dolgov *et al.*, 2005a; 2005b). Bottom-trawl fisheries targeting cod *Gadus morhua* and haddock *Melanogrammus aeglefinus*, and longline fisheries targeting cod, blue catfish *Anarhichas denticulatus* and Greenland halibut *Reinhardtius hippoglossoides* have a skate bycatch, which is generally discarded.

Dolgov *et al.* (2005b) estimated the total catch of skates taken by the Russian fishing fleet operating in the Barents Sea and adjacent waters in 1996–2001, and found that it ranged from 723 to 1891 tonnes (average of 1250 tonnes per year). *A. radiata* accounted for 90–95% of the total skate bycatch. *A. radiata* is also the predominant skate in catches of the Norwegian Reference Fleet operating in ICES Subarea 1, and accounts for around 90% of the catches (Albert *et al*., 2016 WD).

13.2.2 The fishery in 2020

No new information. Since 2012, Norwegian declared skate landings have sharply increased and both in 2015 and 2017 they doubled compared to the previous year (157 tonnes to 369 tonnes, 374 tonnes to 704 tonnes, respectively). The reason for this increase is unknown. After a decrease in Norwegian landings from this area in 2018 (582 tonnes), the landings once again increased in 2019 (849 tonnes) and decreased again in 2020 (670 tonnes). Germany reported between <0.1 tonnes and 5 tonnes landed for the years 2013–2018, but none in 2019–2020.

13.2.3 ICES advice applicable

ICES does not provide advice on the status of skate stocks in this ecoregion.

13.2.4 Management applicable

There are no TACs for any of the skate species in this ecoregion. Norway has a general ban on discarding. Since 2010, all dead or dying skates and other fish in the catches should be landed, whereas live specimens can be released (discarded).

13.3 Catch data

13.3.1 Landings

For ICES Subarea 1, landings data are limited and only available for all skate species combined (Table 13.1). Landings from the most westerly parts of the Barents Sea ecoregion fall within Subarea 2 (see Section 14). Russia and Norway are the main countries landing skates from the Barents Sea, and Figure 13.1 shows their landings from 1973 to 2020. However, Russian landings are not available since 2011.

Elasmobranch landings from ICES Subarea 1 are low, but there have been large fluctuations in Russian landings. The peak in Russian landings in the 1980s corresponded to an experimental fishery for skates, where the bycatch (mainly comprised of *Amblyraja radiata*) was landed (Dolgov, personal communication, 2006).

Based on data from the Norwegian Reference fleets, and the expert judgement detailed in Albert *et al*. (2016 WD), Norwegian landings by species and species groups from ICES Subarea 1 were estimated (Table 13.2). The main species landed tend to be larger specimens of *Raja clavata*, *Bathyraja spinicauda* and *Amblyraja hyperborea*.

13.3.2 Discards

Based on interviews of the Norwegian Reference Fleet and landing sites, the expected discards of skates varied extensively between species and is assumed almost 100% for specimens below 50 cm. For *Rajella fyllae* and *Amblyraja radiata,* nearly all specimens are probably discarded, whereas the discards of *Raja clavata* by the coastal fleet is expected to be negligible (Albert *et al.*, 2016 WD).

13.3.3 Quality of catch data

Recent data on skate catch and landings in the Barents Sea are almost exclusively from Norway, and species information from the Norwegian Reference Fleet (Table 13.2) may be indicative of the total catch and landings. The estimation of total skate catches and landings by species relied on some strong assumptions, e.g. that data from the Coastal and Oceanic Reference Fleets operating in the Barents Sea are representative for vessels below and above 21 m respectively, and that the relative species composition of skate catches in these two reference fleets has been stable over the last ten years. These assumptions were made due to limited availability of data. With increased data and extended time series, these assumptions should be relaxed by including running averages over shorter time periods, e.g. 3–5 years.

Even after allocating skate landings to species based on data from the Reference Fleet, the generic "Skates and rays" category still accounted for more than 50% of the total skate landings. A further reduction of this proportion should however be achievable. The work on improving species identification by arranging workshops for reference fleet crew and education during visits at sea will continue to further improve data quality in the future.

In addition, the splitting of catches by species should be validated by independent surveys. The best way to do this is probably to include skates on the list of species to sample from selected landing ports. Skates are mostly landed as wings in Norway, which can make conventional species identification more difficult (although skate identification could be confirmed with genetic barcoding). Programmes for market sampling of skate landings could usefully be undertaken.

13.3.4 Discard survival

No data available to WGEF for the fisheries in this ecoregion.

13.4 Commercial catch composition

Generally, larger skates are more often caught in longline fisheries than in trawl fisheries (Dolgov *et al.*, 2005b).

Vinnichenko *et al.* (2010 WD) reported that catches of skates in Russian trawl and longline bottom fisheries in 2009 (60–400 m depths) were dominated by *A. radiata* (90–95%). Information on length and sex composition can be found in ICES (2014). Other species occurring were *R. fyllae*, *A. hyperborea*, *B. spinicauda* and *R. lintea*. These findings are supported by data from the Norwegian Reference Fleet (Vollen, 2010 WD; Albert *et al.*, 2016 WD).

Dolgov *et al.* (2005b) reported the mean length and the sex ratio for four species of skate in the Barents Sea. The sex ratio was 1:1 in commercial catches for all skate species except *A. hyperborea*, of which males dominated in the longline fishery (see ICES, 2007 for further information).

13.5 Commercial catch and effort data

Some CPUE data are available for *A. radiata*, *A. hyperborea*, *R. fyllae* and the common skate complex in trawl and longline fisheries, respectively. Total catches of skates in Russian fisheries in the Barents Sea and adjacent areas for the years 1996–2001 were summarized in ICES (2007).

Catch data from other nations are limited and analyses of more recent Russian data are required.

13.6 Fishery-independent surveys

13.6.1 Russian bottom trawl survey (RU-BTr-Q4)

For the offshore areas, data from October–December surveys (RU-BTr-Q4) were available for the years 1996–2003 (Dolgov *et al.*, 2005b; Drevetnyak *et al.*, 2005; summarized in ICES, 2007). These studies described the distribution and habitat utilization of skates (*A. radiata*, *A. hyperborea*, *R. fyllae*, *D. batis* complex, *B. spinicauda* and *R. lintea*) in the Barents Sea.

Vinnichenko *et al.* (2010 WD) reported on catches of *A. radiata* from the 2009 Russian bottom-trawl survey in October–December (RU-BTr-Q4). The overall length range was 8–61 cm total length (TL). The average length of males (41.6 cm TL) was greater than that of females (38.8 cm TL), and the sex ratio was about 1.02:1.

13.6.2 Norwegian coastal survey (NOcoast-Aco-Q4)

The distribution and diversity of elasmobranch species in the northern Norwegian coastal areas were assessed by Williams *et al.* (2008). The results were summarized in ICES (2007; 2008). New data from, for example, the Norwegian coastal survey should be analysed and presented to the WGEF when sufficient data becomes available.

13.6.3 Deep stations from multiple Norwegian surveys (NO-GH-Btr-Q3 and others)

Vollen (2009 WD) reported on elasmobranch catches from deep trawl hauls (400–1400 m) along the continental slope (62–81°N) in 2003–2009. The area investigated covered the Norwegian Sea ecoregion, as well as the border between the Norwegian Sea and Barents Sea ecoregions (see Section 14 of ICES, 2009).

13.6.4 Joint Russian-Norwegian surveys (BS-NoRu-Q1 (BTr), Eco-NoRu-Q3 (Aco)/Eco-NoRu-Q3 (Btr))

Two joint Russian–Norwegian surveys are conducted in the Barents Sea. The surveys run in February (BS-NoRu-Q1 (BTr)), in the southern Barents Sea northwards to the latitude of Bear Island, and August–September (Eco-NoRu-Q3 (Aco)/Eco-NoRu-Q3 (Btr)), covering the whole of the Barents Sea including waters near Spitsbergen and Franz Josef Land. The Norwegian part of the February survey started in 1981, but data on elasmobranchs are missing for some years. The August–September survey started in 2003. All skate species are recorded during these surveys, and length data are collected. Some biological data are also collected on Russian vessels. However, due to initial species identification problems, species-specific data should only be used from the years 2006–2007 onwards (applies also to Norwegian data).

Vinnichenko *et al.* (2010 WD) analysed data on elasmobranch species from the joint surveys in 2009. The results were reported in Section 13 of ICES (2014). Wienerroither *et al*. (2011; 2013) used data from the August–September (Q3) survey (2004–2009) and February (Q1) survey (2007–2012) to describe the spatial distribution of chondrichthyan fishes in the Barents Sea. For some species, length composition are also available. The information on the main skate species is summarized below. It should be noted that length distributions are not directly comparable between the two surveys due to differences in sampling design and coverage in time and area.

A. radiata: The most common skate species in the Barents Sea. Widely distributed in the surveyed area, except in Arctic waters (Figure 13.2). Size distribution was similar in the two surveys, ranging from 5–65 cm (Figure 13.3). Based on a simple swept area model utilizing the Q3 data, the stock appear to vary in both biomass and number of individuals, without showing any apparent trend (Knutsen, *et al*., 2017 WD).

A. hyperborea: The species was found in deeper waters along the shelf edge towards the Norwegian Sea and Polar basin, and in Arctic water in the deeper parts of the eastern Barents Sea (Figure 13.2). The size ranges from 6 to 85 cm. Only few specimens smaller than 38 cm were caught during the Q1 survey, although this size class was very numerous in the Q3 survey (Figure 13.3). The stock increased in biomass and numbers between 2007 and 2014. For the recent years, the estimates have been on the same level as before 2007 (Knutsen *et al*. 2017 WD).

B. spinicauda: During the Q1 survey, the species was found in larger parts of the central basin. During the Q3 survey, the distribution was more towards the western part of the surveyed area (Figure 13.2). Recorded lengths ranged from 6 to 183 cm (Figure 13.3). The largest specimen exceeded the reported maximum length of 172 cm. Fewer small and more large individuals were caught in the Q1 survey than in the Q3 survey. Generally, the stock appear to be relatively stable in terms of biomass and number of individuals (Knutsen *et al*., 2017 WD).

R. fyllae: The species was found in warm-water areas in the southwestern part of the surveyed area, and along the slope west of Svalbard/Spitsbergen (Figure 13.2). The length distribution ranged from 6–60 cm, with two peaks around 10–15 and 46–50 cm (Figure 13.3). Although there is some annual fluctuations in number of individuals in the Barents Sea, the general trend is stable, as is the trend for biomass (Knutsen *et al*., 2017).

13.6.5 Quality of survey data

Species identification for skates is a major issue, especially with some of the earlier data. Williams (2007) gave a detailed description of identification issues for *A. radiata* vs. *R. clavata* in the Norwegian Sea ecoregion.

Furthermore, the occurrence of the common skate complex (possibly confused with *B. spinicauda*) adds potential identification errors (see also Section 26.1). The depth distribution of the two species in Dolgov *et al*. (2005a) and *L. fullonica* in the Barents Sea has been questioned by Lynghammar *et al.* (2014), as no specimens could be obtained for genetic analyses since 2007. Consequently, appropriate quality checks of these survey data are required prior to use in assessments.

In order to improve quality of current survey data, better identification practices using appropriate identification literature needs to be put in place. Ongoing work to improve future sampling at IMR includes workshops to educate staff as well as improved field guides and keys used for species identification. A workshop series in 2019 established the basis for an updated identification guide to be used for surveys and by the reference fleet.

13.7 Life-history information

Length data for *A. radiata*, *A. hyperborea*, *R. fyllae*, common skate complex and *B. spinicauda* are available in Dolgov *et al.* (2005a; 2005b) and Vinnichenko *et al.* (2010 WD; see ICES, 2007; 2010). Some biological information is available in the literature (e.g. Berestovskii, 1994). Sampling of elasmobranch egg cases has been included in Norwegian trawl surveys from mid-2009, and may provide future information on egg-laying (spawning) grounds.

13.8 Exploratory assessment models

No exploratory assessments have been conducted, due to the limited data available. Analyses of survey trends may allow to evaluate the status of the more frequent species, although taxonomic irregularities need to be addressed first.

13.9 Exploratory assessment models

No assessments have been conducted.

13.10 Quality of assessments

No assessments have been conducted.

13.11 Reference points

No reference points have been proposed.

13.12 Conservation considerations

See Section 12.11.

13.13 Management considerations

Landings of skates in this ecoregion have steadily increased in the recent years, with a peak in 2019. There are no TACs for any of the demersal skate stocks in this region.

The elasmobranch fauna of the Barents Sea comprises relatively few species. The most abundant skate in the area is *A. radiata*, which is widespread and abundant in this ecoregion and adjacent waters. This species dominated the large historical Russian landings, but is otherwise generally discarded.

Data from the Norwegian Reference Fleet indicate that the most commonly landed skates today are larger specimens of *Raja clavata*, *Batyhraja spinicauda* and *Amblyraja hyperborea.* These are not abundant in the Barents Sea and the information on stock status is limited.

Further studies are required, particularly for the larger-bodied skates, which may be more vulnerable to overfishing.

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Table 13.1. Demersal elasmobranchs in the Barents Sea. Total landings (t) of skates from ICES Subarea 1 (1973–2020); "n.a." = no data available, "." = zero catch, "+" = <0.5 tonnes.

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Belgium	.	.	.	1	.	.	.	.	.	.	.	.	.	.
France	.	.	.	81	49	44	.	.	.	.	.	.	.	.
Germany	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Iceland	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Norway	.	.	.	1	3	4	8	2	2	2	1	10	11	3
Portugal	.	.	100	11	1	.	.	+	.	.	.	.	.	.
USSR/Russian Fed.	n.a.	n.a.	n.a.	n.a.	n.a.	1126	168	93	3	1	n.a.	563	619	2137
Spain	.	.	.	.	.	.	.	.	.	.	.	.	.	.
UK(E&W)	78	46	49	33	70	9	8	4	+	1	.	+	+	+
UK(Scotland)	.	.	1	2	2	.	.	.	.	.	.	.	.	.
Total	78	46	150	129	125	1183	184	99	5	4	1	573	630	2140
	1987	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Belgium	.	.	.	.	.	.	.	.	.	.	.	.	.	.
France	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Germany	.	.	.	.	.	.	.	2	.	.	.	.	.	.
Iceland	.	.	.	.	.	.	1	.	.	+	1	.	.	4
Norway	14	7	4	1	5	24	29	72	9	27	3	13	21	12
Portugal	.	.	.	.	.	.	.	.	.	.	.	.	.	.
USSR/Russian Fed.	2364	2051	1235	246	n.a.	399	390	369	n.a.	n.a.	399	790	568	502
Spain	.	.	.	.	.	.	.	.	7	.	.	.	.	.
UK(E&W)	2	.	+	.	.	.	.	.	.	.	.	.	+	.
UK(Scotland)	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Total	2380	2058	1239	247	5	423	420	443	16	27	403	803	589	518

Table 13.1 (continued). Demersal elasmobranchs in the Barents Sea. Total landings (t) of skates from ICES Subarea 1 (1973–2020); "n.a." = no data available, "." = zero catch, "+" = <0.5 tonnes.

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Belgium	.	.	.	.	.	.	.	.	.	.	.	.	.	.
France	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Germany	.	.	.	.	.	.	+	.	.	+	.	.	+	+
Iceland	.	.	.	3	3	.	.	.	.	.	.	1	8	.
Norway	30	26	2	1	4	13	4	72	15	9	31	109	172	157
Portugal	.	.	.	+	.	.	.	.	.	.	.	.	.	.
USSR/Russian Fed.	218	173	38	69	37	48	24	6	2	1	n.a.	n.a.	n.a.	n.a.
Spain	.	.	.	.	.	.	.	.	.	.	.	.	.	.
UK(E&W)	.	.	.	.	.	.	.	.	.	.	+	.	.	.
UK(Scotland)	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Total	248	199	40	73	44	61	28	78	17	10	31	109	179	157

	2015	2016	2017	2018	2019	2020
Belgium	.	.	.	.	.	.
France	.	.	.	.	.	.
Germany	5	2	+	2	.	.
Iceland	.	.	.	.	.	.
Norway	369	374	704	582	849	670
Portugal	.	.	.	.	.	.
USSR/Russian Fed.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Spain	.	.	.	.	.	.
UK(E&W)	.	.	.	.	.	.
UK(Scotland)	.	.	.	.	.	.
Total	374	376	704	584	849	670

Table 13.2. Demersal elasmobranchs in the Barents Sea. Estimated Norwegian landings (t) of skates and rays by species in ICES Subarea 1. Source: Albert *et al.* (2016 WD).

Species	2012	2013	2014	2015
Amblyraja hyperborea	10	17	2	14
Bathyraja spinicauda	13	22	3	19
Dipturus oxyrinchus	1	1	0	1
Raja clavata	10	13	25	50
Rajidae indet.	76	116	127	285
Total	108	170	157	368

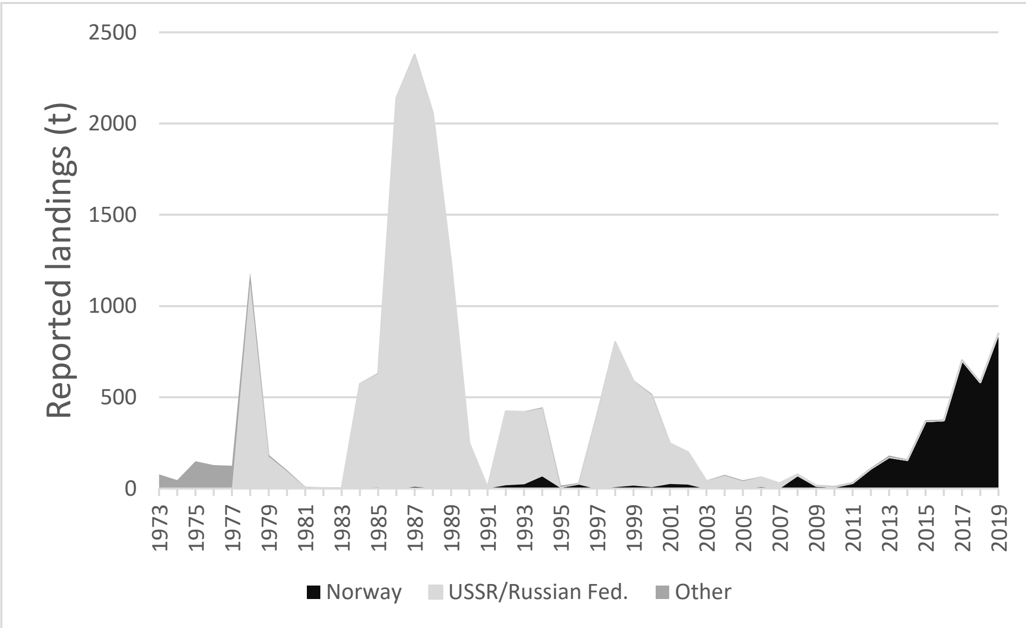

Figure 13.1. Demersal elasmobranchs in the Barents Sea. Reported landings (t) of skates from ICES Subarea 1 (1973–2019).

Q1 **Q3**

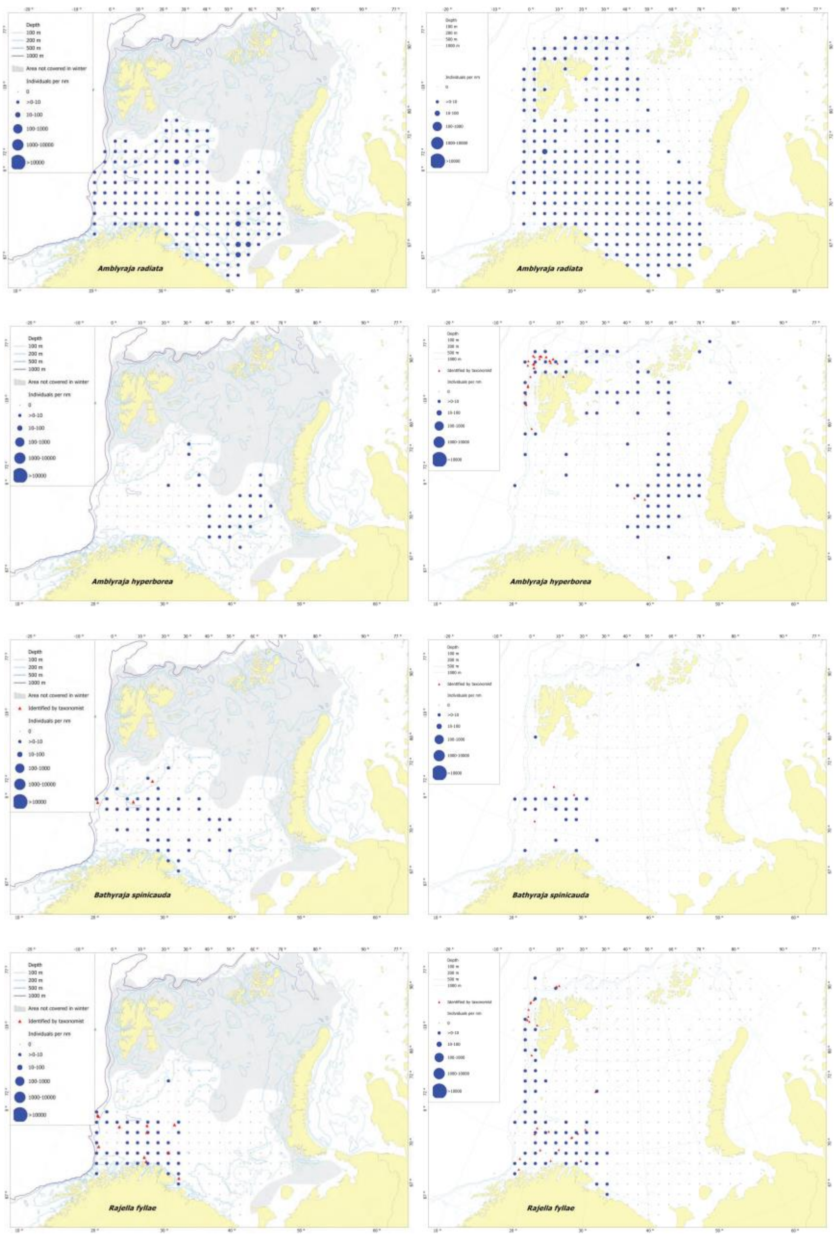

Figure 13.2. Demersal elasmobranchs in the Barents Sea. Spatial distribution of *A. radiata*, *A. hyperborea*, *B. spinicauda* and *R. fyllae* (top to bottom) in Q1 (left) and Q3 (right) Joint Russian–Norwegian surveys. Source: Wienerroither *et al*. (2011, 2013).

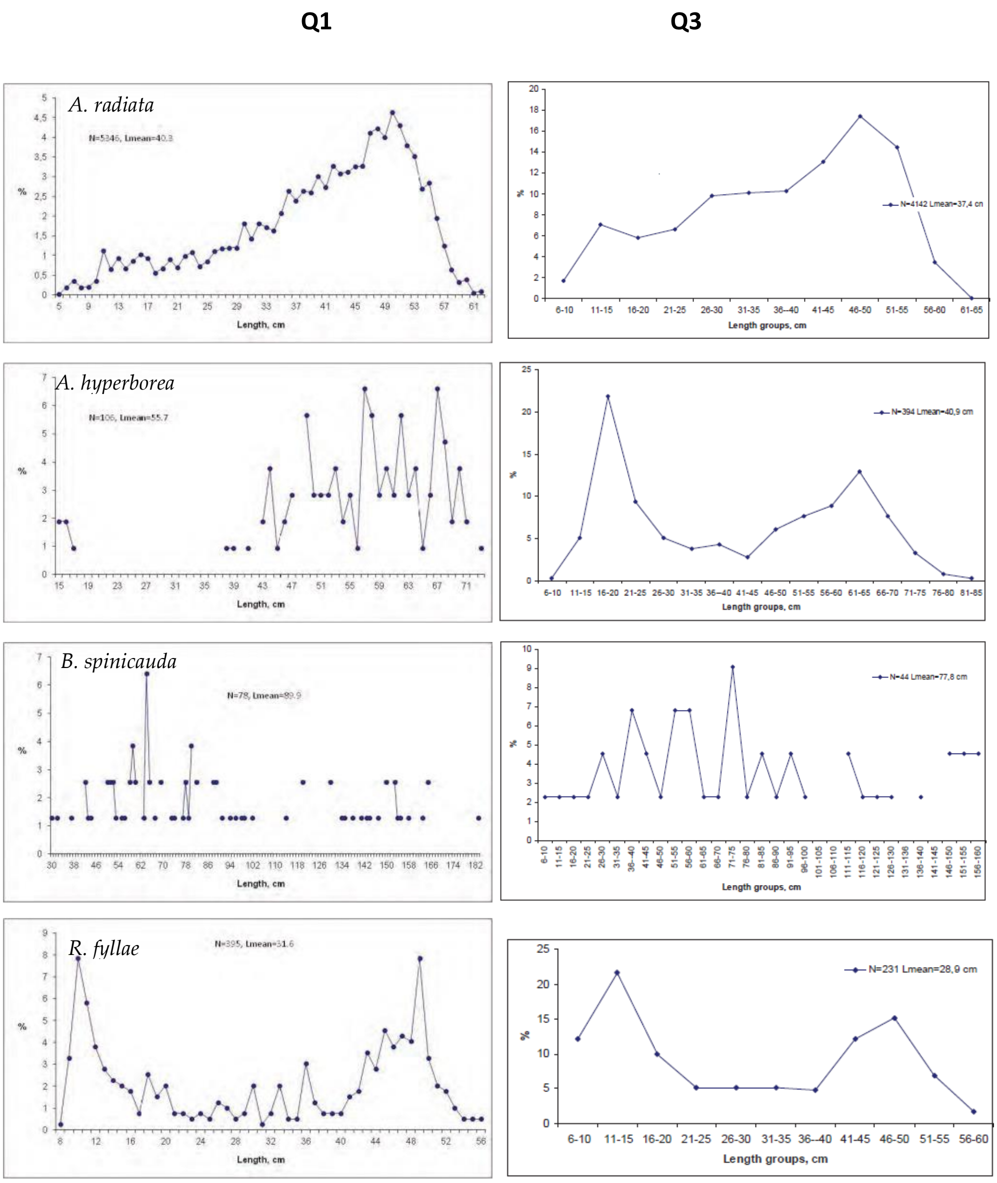

Figure 13.3. Demersal elasmobranchs in the Barents Sea. Length distributions of *A. radiata*, *A. hyperborea*, *B. spinicauda* and *R. fyllae* (top to bottom) in Q1 (left) and Q3 (right) Joint Russian–Norwegian surveys. Note that length distributions are not directly comparable between the two surveys. Source: Wienerroither *et al*. (2011, 2013).

14 Demersal elasmobranchs in the Norwegian Sea

14.1 Ecoregion and stock boundaries

The Norwegian Sea connects with the Northeast Atlantic Ocean to the southwest, the Icelandic Waters ecoregion and Greenland Sea to the west along the edge to the shallower Iceland Sea between the Faroe Islands, and northwards to Jan Mayen. To the south it borders to the shallower North Sea along the 62°N parallel between Norway and the Faroe Islands, and to the northeast with the shallower Barents Sea (ICES 2019). It comprises ICES Divisions 2.a-b.

The occurrence of chondrichthyan species in the Norwegian Sea ecoregion was reviewed by Lynghammar *et al*. (2013). In coastal areas, thorny skate *Amblyraja radiata* is the most abundant skate species (Williams *et al*., 2008). While more abundant in the north, this species is common at all latitudes along the Norwegian coast.

Other species that have been confirmed in the coastal area are thornback ray *Raja clavata*, common skate complex (most likely flapper skate *Dipturus intermedius* (Lynghammar *et al*., 2014; C. Junge, pers. obs.), sailray *Rajella lintea*, Norwegian skate *Dipturus nidarosiensis*, sandy ray *Leucoraja circularis*, shagreen ray *Leucoraja fullonica*, round skate *Rajella fyllae*, arctic skate *Amblyraja hyperborea* and spinytail skate *Bathyraja spinicauda*. Long-nose skate *Dipturus oxyrinchus* is distributed mainly along the southern section of the coastline, south of latitude 65°N. Records of blond ray *R. brachyura* and spotted ray *R. montagui* need to be confirmed by voucher specimens, although they are present in catch statistics (Lynghammar *et al*., 2014).

In deeper areas of the Norwegian Sea, *A. radiata* and *A. hyperborea* are the two most abundant species, but *B. spinicauda* and *R. fyllae* also occur regularly, particularly north of 70°N (Skjaeraasen and Bergstad, 2001; Vollen, 2009 WD).

Sharks in the Norwegian Sea ecoregion include spurdog *Squalus acanthias* (Section 2) velvet belly lanternshark *Etmopterus spinax* (Section 5), porbeagle *Lamna nasus* (Section 6), basking shark *Cetorhinus maximus* (Section 7), Greenland shark *Somniosus microcephalus* (Section 24), black-mouth catshark *Galeus melastomus* and lesser-spotted dogfish *Scyliorhinus canicula* (Section 25). One chimaera, the rabbitfish *Chimaera monstrosa* is also found in the Norwegian Sea.

Stock boundaries of skates and rays in the Norwegian Sea are not known, neither are the potential movements of species between the coastal and offshore areas. Further investigations are necessary to determine potential migrations or interactions of elasmobranch populations within this ecoregion and adjacent areas.

14.2 The fishery

14.2.1 History of the fishery

There are no fisheries targeting skates or sharks in the Norwegian Sea, though they are caught in various demersal fisheries targeting teleost species. All skate species in the ecoregion may be taken as bycatch, with only larger individuals thought to be landed (see Section 14.3).

14.2.2 The fishery in 2020

No new information.

14.2.3 ICES advice applicable

ICES does not provide advice for the skate stocks in this ecoregion, although some stocks of North Sea skates may extend into the southern parts of the Norwegian Sea.

14.2.4 Management applicable

There are no TACs for any of the skate stocks in this ecoregion.

Norway has a general ban on discarding. Since 2010, all dead or dying skates in the catches should be landed, whereas live specimens can be discarded.

14.3 Catch data

14.3.1 Landings

Landings data for skates are provided for the years 1973–2020 (Table 14.1). For ICES Subarea 2, landings data are limited and, for skates, aggregated across all species. This Subarea covers all of the Norwegian Sea ecoregion, but also includes the most westerly parts of the Barents Sea ecoregion (Section 13).

Overall landings throughout time have been low, ca. 200–330 t per year for all fishing countries, with moderate fluctuations. The peak in the late 1980s resulted from Russian fisheries landing over 1900 t of skates in 1987, subsequently dropping to low levels two years later. This peak was a consequence of an experimental fishery, when skate bycatch was landed, whereas normally they are discarded (Dolgov, pers. comm.). Russia and Norway are the main countries landing skates from the Norwegian Sea and Figure 14.1 shows their landings from 1973 to 2020.

Landings data (usually not discriminated at species level) since 2010 have been provided by Norway (2010–2020), France (2010–2013), Germany (2010, 2013–2020), the UK (2010–2011, 2013, 2015–2016), Spain (2010, 2012–2014) and the Netherlands (2015). Russian landings have not been available since 2010.

Based on data from the Norwegian Reference fleets, and the expert judgement detailed in Albert *et al*. (2016 WD), Norwegian landings by species and species groups from ICES Subarea 2 were estimated (Table 14.2). The main species landed tend to be larger specimens of *Dipturus oxyrinchus*, *Bathyraja spinicauda* and *Raja clavata.*

14.3.2 Discard data

Based on interviews of the Norwegian Reference Fleet and landing sites, the expected discards of skates varies extensively between species and is assumed almost 100% for specimens below 50 cm. For *Rajella fyllae* and *Amblyraja radiata,* nearly all specimens are probably discarded, whereas the discarding of *Raja clavata* by the coastal fleet is expected to be negligible (Albert *et al*., 2016 WD).

14.3.3 Quality of catch data

Catch data are not species disaggregated.

Recent data on skate catch and landings in the Norwegian Sea are almost exclusively from Norway, and species information from the Norwegian Reference Fleet (Table 14.2) may be indicative of the total catch and landings. The estimation of total skate catches and landings by species relied on some strong assumptions, e.g. that data from the Coastal and Oceanic Reference Fleets operating in the Norwegian Sea are representative for vessels below and above 21 m respectively, and that the relative species composition of skate catches in either of these two reference fleets has been stable over the last ten years. These assumptions were made due to limited availability of data. With increased data and extended time series, these assumptions should be relaxed by including running averages over shorter time periods, e.g. 3–5 years.

Even after allocating skate landings to species based on data from the Reference Fleet, the generic "Skates and rays" category still accounted for about 30% of the total skate landings. A further reduction of this proportion should however be achievable. The work on improving species identification by arranging workshops for reference fleet crew and education during visits at sea will continue to further improve data quality in the future.

In addition, the splitting by species should also be validated by independent surveys. The best way to do this is probably to include skates on the list of species sampled from selected landing ports. Skates are mostly landed as wings in Norway, which can make conventional species identification more difficult (although skate identification could be confirmed with genetic barcoding). Programmes for market sampling of skate landings could usefully be undertaken.

14.3.4 Discard survival

No data available to WGEF for the fisheries in this ecoregion.

14.4 Commercial catch composition

14.4.1 Species and size composition

In 2009, Russian landings of skates were taken as bycatch during the longline and trawl demersal fisheries at depths ranging from 50–900 m deep in February–November. The main skate caught was *A. radiata*, with A. *fyllae*, *A. hyperborea* and *B. spinicauda* found in minor quantities (Vinnichenko *et al.*, 2010 WD).

A. radiata (27–58 cm L_T) were recorded in the commercial bottom-trawl catches, comprising mostly males of 41–55 cm and females of 36–50 cm (Figure 14.2a). The proportion of small individuals was lower than in the Barents Sea. The mean length of females (43.7 cm) was smaller than that of males (45.0 cm). Males were slightly more abundant in catches (sex ratio of 1.1:1).

Vinnichenko *et al.* (2010 WD) presented data on *A. radiata* compiled from samples taken by scientific observers on commercial fishing vessels, the Russian survey and the joint Russian–Norwegian surveys. These are presented in Section 14.6.4.

14.4.2 Quality of the data

Information on the species composition of commercial catches is required.

Data from the Norwegian Reference Fleet demonstrated that elasmobranch catches in ICES Subarea 2 were dominated by *A. radiata* and *R. clavata* (Table 14.2; Vollen, 2010 WD), although misidentification problems may exist. For vessels in the Oceanic Reference Fleet, elasmobranch bycatch differed between bottom trawl, bottom gillnet and longline. Whereas *A. radiata* made up the bulk of trawl and longline catches (55% and 79% by numbers, respectively), *R. clavata* dominated in gillnet catches (82%). This was probably influenced by the dominance of trawl and longline vessels further north, and more southerly fishing grounds for gillnetters, but potential misidentifications issues should also be investigated. Catches of *A. radiata* were higher in Subarea 2 than in Subarea 1 for trawl catches (61 kg per 100 trawl hours for Subarea 2; 43 kg per 100 trawl hours for Subarea 1), but lower for longline catches (119 kg per 10 000 hooks vs. 135 kg per 10 000 hooks, respectively).

Data from the Coastal Reference Fleet indicated that the common skate complex (most likely misidentified) and unidentified skates dominated the landed catches in this area (39% and 33% by weight, respectively). Discards were dominated by unidentified skates (32% by weight). As opposed to the Oceanic Reference Fleet, *A. radiata* was only sporadically recorded in this area.

14.5 Commercial catch and effort data

Limited data available (but see above).

14.6 Fishery-independent surveys

14.6.1 Russian bottom trawl survey (RU-BTr-Q4)

Vinnichenko *et al.* (2010 WD) reported that catches from the 2009 survey were dominated by *A. radiata* (10–56 cm L_T; Figure 14.2b). In the size distribution, different size/age classes of the skate were very distinct. The mean length of males (37.7 cm) and females (37.4 cm) were similar, and males predominated slightly (sex ratio = 1.05:1).

A. hyperborea (17–91 cm L_T) were recorded in the catches (Figure 14.2d; specimens > 131 cm were not considered here as they are thought to be typing errors or species misidentifications). The mean length of males (65.1 cm) and females (65.8 cm) were similar, and mostly males were caught (sex ratio = 5:1).

14.6.2 Norwegian coastal survey (NOcoast-Aco-4Q)

The distribution and diversity of elasmobranchs in northern Norwegian coastal areas, based on survey data from 1992–2005, were summarized by Williams *et al.* (2008). The southern portion of the coastal area studied was incorporated within the Norwegian Sea ecoregion, and the Barents Sea was defined as the border between Norwegian Directorate of Fisheries Statistical Areas 04 and 05 (https://portal.fiskeridir.no/portal/apps/webappviewer/index.html?id=ea6c536f760548fe9f56e6edcc4825d8).

Thirteen skate species and four species of shark were recorded from the coastal region (Table 14.3). Regularly occurring skates were *A. radiata, A. hyperborea,* common skate complex (most likely *Dipturus intermedius* (Junge/Lynghammar, pers. comm)), *D. nidarosiensis, D. oxyrinchus, Raja clavata, Rajella fyllae, L. fullonica*. Occasional or single observations were made of *B. spinicauda*, *R. lintea* and *L. circularis* (also *R. montagui*, *R. brachyura* were nominally recorded, but see Section 14.6.5). Four species of shark were identified: *E. spinax, G. melastomus* and *S. acanthias*, as well as one specimen of *S. microcephalus.*

A. radiata appear to fluctuate in both biomass and numbers, but the stock had an increasing trend in 2008–2016 (Knutsen *et al*., 2017 WD). *D. oxyrinchus* also fluctuated in biomass, but only slightly in numbers, indicating variance in size composition of the survey catch between years. However, the overall trends in biomass and numbers were positive. The estimates of biomass and abundance of *R. fyllae* were stable over the time-series (2003–2016) (Knutsen *et al*., 2017 WD).

Although no clear shifts in abundance over time were detected for any species, more robust assessment is necessary to better identify temporal trends in abundances.

14.6.3 Deep stations from multiple Norwegian surveys (NO-GH-Btr-Q3 and others)

Vollen (2009 WD) reported on elasmobranch catches from 3185 deep trawl hauls (400–1400 m) along the continental slope (62–81°N) from the Barents Sea to the Skagerrak. Data were combined from multiple deep-water surveys during the period 2003–2009. Data from the Skagerrak are excluded in this section, whereas parts of the Barents Sea ecoregion are included. Overall, nine species (six skates and three sharks) were recorded. *A. radiata* and *A. hyperborea* were the dominant species north of 62°N (ICES Subarea 2), whereas *E. spinax* was most numerous in the Norwegian Deep (Division 3.a). *B. spinicauda* and *R. fyllae* also occurred frequently in the catches in all areas. Reports of *R. clavata* were considered to be misidentifications of other species. Results were reported in more detail in ICES (2009).

14.6.4 Joint Russian-Norwegian survey (BS-NoRu-Q1 (BTr), Eco-NoRu-Q3 (Aco)/Eco-NoRu-Q3 (Btr))

Two joint Russian–Norwegian surveys are conducted in the Barents Sea: one during February (BS-NoRu-Q1 (BTr)), in the southern Barents Sea northwards to the latitude of Bear Island, and another in August–September (Eco-NoRu-Q3 (Aco)/Eco-NoRu-Q3 (Btr)), covering much of the Barents Sea, including waters near Spitsbergen and Franz Josef Land. The Norwegian part of the February survey started in 1981, but data on elasmobranchs are missing for some years. The August–September survey started in 2003. All skates are recorded during these surveys, and data on length distributions as well as some biological data (on board of Russian vessels) are collected. As a result of initial problems with species identification, species-specific data should only be used from the years 2006–2007 onwards (for Norwegian data). Analyses of data from these surveys are not complete, but some data from the 2009 surveys were presented by Vinnichenko *et al.* (2010 WD).

A. radiata was the dominant species in the August–September survey. The length range was 5–61 cm total length (TL), with most specimens in the range 33–37 cm (Figure 14.2c; Vinnichenko *et al.*, 2010 WD).

Vinnichenko *et al.* (2010 WD) also presented data on *A. radiata* compiled for samples collected by scientific observers on commercial fishing vessels, the Russian survey and the joint Russian–Norwegian surveys. Males prevailed in the samples (1.7:1). Most males and females (over 70%) were immature, the rest were in developing stages or were mature. Unlike in the Barents Sea, no individuals at the active stage were reported in the area. The main prey (by weight) were crustaceans (spider crab *Hyas* spp.: 33%; northern shrimp *Pandalus borealis*: 14%; amphipods: 6%), fish (capelin *Mallotus villosus*: 14%; Atlantic hookear sculpin *Artediellus atlanticus*: 12%; unidentified fish remains: 6%) and polychaete worms.

14.6.5 Quality of survey data

The difficulties associated in identifying skate species are a concern when considering the validity of the data used for any assessment. Identification problems between *A. radiata* and *R. clavata* were highlighted by Williams (2007) and summarized in ICES (2007). Despite sampling since 2007, Lynghammar *et al.* (2014) did not catch any specimens of common blue skate *Dipturus batis*, *R. brachyura* or *R. montagui* in the Norwegian Sea: giving more credence to suspected misidentification in earlier year. *D. intermedius* may occur in small numbers in the Norwegian Sea. Indeed, the record of *R. montagui* from central Norway was known from a museum specimen, but

Lynghammar *et al.* (2014) identified it as *R. clavata*. There were also no contemporary records of *L. fullonica*, though this species was reported in historical accounts.

In order to achieve a better quality of survey data, it is important to improve the identification practices, using appropriate identification literature. Ongoing work to improve sampling at the Institute of Marine Research includes workshops to educate staff as well as improved guides and keys used for species identification, including a new simplified guide for commercial longliners since Jan 2021. A workshop series in 2019 established the basis for an updated complete identification guide to be used for surveys and by the reference fleet.

14.7 Life-history information

Some length data are available for *A. radiata* and *A. hyperborea* (Vinnichenko *et al.*, 2010 WD; ICES, 2010). Some biological information is available in the literature (e.g. Berestovskii, 1994). Sampling of elasmobranch egg-cases was included in Norwegian trawl surveys from mid-2009 until 2020 (from 2021: egg cases are still recorded but only sampled when caught in large numbers per station), which may provide future information on nursery grounds.

14.8 Exploratory assessment models

No exploratory assessments have been conducted, due to the limited data available. Analyses of survey trends may allow evaluation of the status of more frequently caught species, although taxonomic irregularities need to be addressed first.

14.9 Stock assessment

No assessments have been conducted.

14.10 Quality of assessments

No assessments have been conducted.

14.11 Reference points

No reference points have been proposed for any of these skate stocks.

14.12 Conservation considerations

The International Union for Conservation of Nature and Natural Resources (IUCN Red List of Threatened species (IUCN, 2014) listings for species occurring in this area include (assessment year in parentheses):

- "Critically endangered": common skate complex (2006; Europe: 2015) – this complex comprises *Dipturus batis* and *Dipturus intermedius* but their status has not been assessed on a species level yet;
- "Endangered": *L. circularis* (2014);
- "Vulnerable": *L. fullonica* (2014);
- "Near threatened": *B. spinicauda* (2006), *D. nidarosiensis* (2014), *D. oxyrinchus* (2014) and *R. clavata* (2005; Europe: 2014).

Demersal elasmobranchs listed on the Norwegian Red List (Nedreaas *et al.*, 2015), excluding species assessed as "Least concern", is only the common skate complex ("Critically endangered").

14.13 Management considerations

There are no TACs for any of the skates in this ecoregion. The demersal elasmobranch fauna of the Norwegian Sea comprises several species that also occur in the Barents Sea (Section 13) and/or the North Sea (Section 15). Further investigations are required and could also offer valuable additional information for managing the neighbouring ecoregions.

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Table 14.1. Demersal elasmobranchs in the Norwegian Sea. Total landings (t) of skates from ICES Subarea 2 (and Division 2.a and 2.b) from 1973–2020. "n.a." = no data available, "." = means zero catch, "+" = < 0.5 tonnes. Countries with only occasional catches are not included by country in the landings table: Denmark (1994), Belgium (1 tonne 1975), Sweden (+ in 1975), Netherlands (1979, 2015), Iceland (2001, 2011), Estonia (2002, 2005), and Ireland (2007, 2009). Species included are: *A. radiata, D. licha, D. pastinaca, D. spp., L. circularis, L. fullonica, L. naevus, M. aquila, R. brachyura, R. clavata, R. montagui, R. alba, T. marmorata*, Rajiformes (indet).

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Faroe Islands	.	.	.	5	2	1	1	.	.	.	.	.	.	4
France	.	.	1	68	61	18	2	1	12	109	2	6	5	11
Germany	+	1	52	12	59	114	84	85	53	7	2	112	124	102
Norway	201	158	89	34	99	82	126	191	137	110	96	150	104	133
Portugal	.	.	.	34	39	.	.	.	.	.	.	.	.	.
USSR/Russ. Fed.	.	.	.	.	.	302	99	39	.	.	.	537	261	1633
Spain	.	.	.	.	.	.	.	.	.	.	28		17	5
UK – E, W & NI	65	18	14	20	90	10	6	2	+	+	.	5	1	2
UK – Scotland	2	1	.	+	1	+	.	.	.	.	.	.	+	+
Other	.	.	1	.	.	.	2	.	.	.	.	.	.	.
Total	268	178	157	173	351	527	320	318	202	226	128	810	512	1890
	1987	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Faroe Islands	.	15	.	42	.	2	.	.	.	.	.	.	.	.
France	21	42	8	56	11	15	9	7	8	6	8	5	.	5
Germany	95	76	32	52	.	+	.	.	.	.	.	.	.	2
Norway	214	112	148	216	235	135	286	151	239	198	169	214	239	244
Portugal	.	.	.	.	.	.	22	11	.	10	28	46	10	6
USSR/Russ. Fed.	1921	1647	867	208	n.a.	181	112	257	n.a.	n.a.	77	139	247	400
Spain	.	9	.	.	.	.	.	.	3	.	3	15	6	.
UK - E, W & NI	4	.	2	1	+	1	+	+	1	4	.	+	1	+
UK – Scotland	2	+	+	+	+	+	+	.	+	+	+	+	1	1
Other	.	.	.	.	.	.	.	+	.	.	.	.	.	.
Total	2257	1902	1057	575	246	334	429	426	251	218	285	419	504	658

Table 14.1 cont'. Demersal elasmobranchs in the Norwegian Sea. Total landings (t) of skates from ICES Subarea 2 (and Division 2.a and 2.b) from 1973–2020. "n.a." = no data available, "." = means zero catch, "+" = < 0.5 tonnes. Countries with only occasional catches are not included by country in the landings table: Denmark (1994), Belgium (1 tonne 1975), Sweden (+ in 1975), Netherlands (1979, 2015), Iceland (2001, 2011), Estonia (2002, 2005), and Ireland (2007, 2009). Species included are: *A. radiata, D. licha, D. pastinaca, D. spp., L. circularis, L. fullonica, L. naevus, M. aquila, R. brachyura, R. clavata, R. montagui, R. alba, T. marmorata*, Rajiformes (indet).

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Faroe Islands	.	.	2	12	15	13	9	13	4	3	n.a.	.	n.a.	n.a.
France	4	7	2	7	9	7	2	5	3	5	1	1	+	+
Germany	.	2	2	7	1	.	.	.	+	1	.	.	1	2
Norway	233	118	111	142	133	146	189	259	258	250	198	121	147	105
Portugal	3	.	8	2	1	14	13	2	.	.	.	.	.	.
USSR/Russ. Fed.	113	38	6	50	20	16	20	.	8	2	n.a.	n.a.	n.a.	n.a.
Spain	7	11	32	.	1	.	.	.	.	+	.	+	1	+
UK - E, W & NI*		.	.	.	2	4	1	1	+	+	+	.	1	.
UK – Scotland*	1	3	3	.	.	.	.	.	.	.	.	.	.	.
Other	4	5	.	.	.	.	1	.	+	.	.	.	.	.
Total	365	184	166	220	165	186	226	268	269	259	200	122	149	108

	2015	2016	2017	2018	2019	2020
Faroe Islands	.	.	.	.	.	.
France	.	.	.	.	.	.
Germany	2	1	1	6	+	-
Norway	112	198	111	213	275	328
Portugal	.	.	.	.	.	.
USSR/Russ. Fed.	.	.	.	.	.	.
Spain	.	.	.	.	.	.
UK (combined)*	2	+	.	.	.	.
Other	+	.	.	.	.	.
Total	115	200	112	219	276	328

Table 14.2. Demersal elasmobranchs in the Norwegian Sea. Estimated Norwegian landings (tonnes) of skates and rays by species in ICES Subarea 2. Source: Albert *et al*. (2016 WD).

	2012	2013	2014	2015
Amblyraja hyperborea	9	11	7	10
Bathyraja spinicauda	23	28	19	23
Common skate complex (most likely *Dipturus intermedius*)	7	9	7	7
Dipturus oxyrinchus	23	28	23	20
Leucoraja circularis	2	2	2	2
Leucoraja fullonica	1	1	1	1
Raja clavata	14	17	14	12
Rajella lintea	6	7	5	6
Rajidae indet.	36	43	27	32
Total	121	146	104	112

Table 14.3. Catch data (number of individuals per species) for the Norwegian Sea ecoregion from the Annual Autumn Bottom-trawl Surveys of the North Norwegian Coast, from 1992 to 2005. Adapted from Williams *et al.* (2007 WD).

Species	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Total catch	Total % of positive samples	Catch rate (No. per survey)
Amblyraja radiata	7	44	23	15	8	41	9	16	9	6	10	10	19	9	226	11%	17.4
Bathyraja spinicauda	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0%	0.1
Rajella fyllae	0	4	0	0	0	1	0	0	0	0	5	6	4	0	20	1%	1.5
Raja clavata	0	4	15	1	0	2	3	6	0	0	0	0	2	0	33	2%	2.5
Common skate complex (most likely *Dipturus intermedius*)	0	2	0	1	3	7	7	1	1	1	1	0	0	0	24	1%	1.8
Leucoraja fullonica	0	0	0	0	0	0	0	4	3	9	3	0	0	1	20	1%	1.5
Leucoraja circularis	0	0	0	0	0	0	0	0	1	0	1	9	5	7	23	1%	1.8
*Raja montagui**	0	0	0	0	0	0	0	2	1	0	1	0	1	0	5	<1%	0.4
Dipturus oxyrinchus	0	0	54	3	2	30	2	0	0	1	2	6	4	2	106	5%	8.2
Dipturus nidarosiensis	0	0	0	0	1	1	0	0	0	3	1	0	1	0	7	<1%	0.5
Amblyraja hyperborea	0	0	1	0	0	0	0	0	0	0	4	0	1	0	6	<1%	0.5
*Raja brachyura**	0	0	4	0	0	0	0	0	0	0	0	0	0	0	4	<1%	0.3
Rajella lintea	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	<1%	0.1
Galeus melastomus	0	24	1883	1197	105	1269	189	480	258	812	1196	275	640	48	8376	24%	644.3
Etmopterus spinax	0	829	8453	473	1061	2733	584	3881	1485	1401	2417	785	2305	1369	27 776	33%	2136.6
Squalus acanthias	0	21	51	26	20	5	106	168	12	68	43	21	104	17	662	8%	50.9
Somniosus microcephalus	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	<1%	0.1
Number of samples	17	163	106	77	74	96	78	81	76	56	78	65	77	63			

***Probably misidentifications, the occurrence of the species in the area has not been confirmed (see Section 14.6.5).**

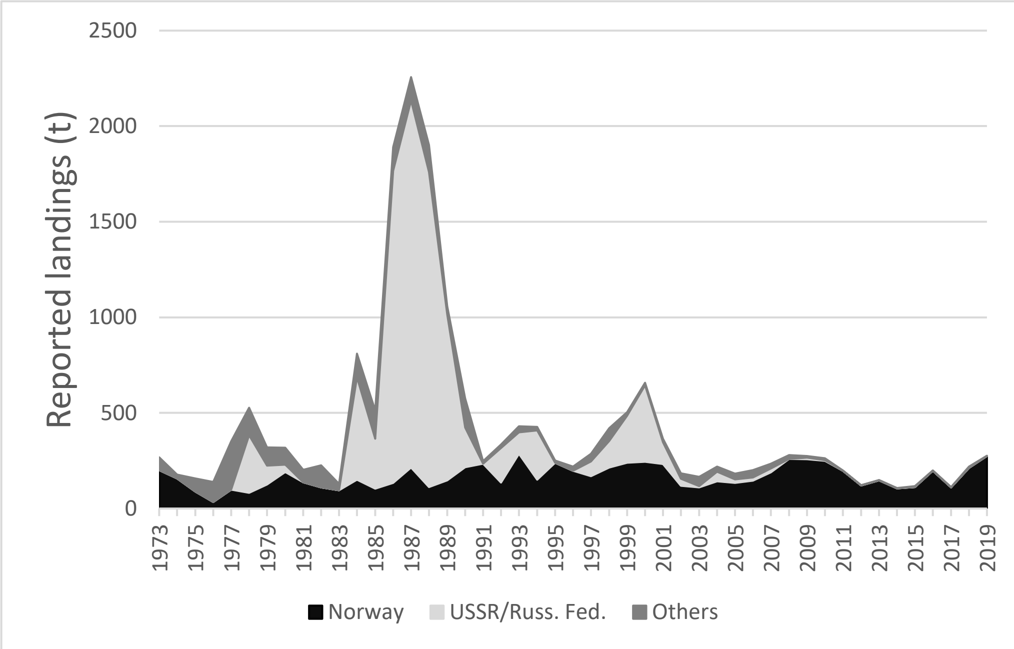

Figure 14.1. Demersal elasmobranchs in the Norwegian Sea. Total landings (t) of skates from ICES Subarea 2 (1973–2019).

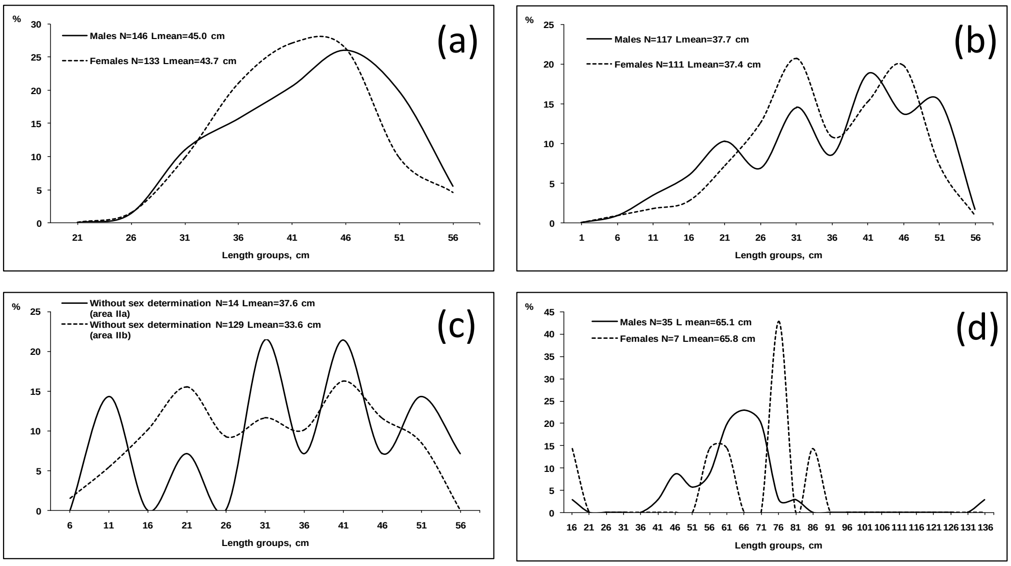

Figure 14.2. Demersal elasmobranchs in the Norwegian Sea showing the length composition of *A. radiata* in (a) commercial bottom-trawl catches in the Norwegian Sea in 2009, (b) Russian demersal survey (October–December 2009) and (c) the Norwegian Sea based on data from the joint Russian–Norwegian ecosystem survey (August–September 2009); and (d) length composition of *A. hyperborea* in the Norwegian Sea (Division 2.b) from the Russian demersal survey (October–December 2009). Specimens exceeding 131 cm are probably typing errors or misidentifications. Source: Vinnichenko *et al*. (2010 WD).

15 Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel

15.1 Ecoregion and stock boundaries

In the North Sea, about ten skate and ray species occur, as well as about ten demersal shark species (Daan *et al.*, 2005). Thornback ray *Raja clavata* is the most important skate for the commercial fisheries. Preliminary assessments on this species were presented in ICES (2005, 2007), based on research survey data. WGEF is still concerned about the possibility of misidentification of skates in some recent IBTS surveys, especially differentiation between *R. clavata* and starry ray *Amblyraja radiata*.

R. clavata in the Greater Thames Estuary (southern part of Division 4.c) is known to move into the eastern English Channel (Walker *et al.*, 1997; Ellis *et al.*, 2008b). For most other demersal species in the North Sea ecoregions, stock boundaries are not well known. Stocks of cuckoo ray *Leucoraja naevus*, spotted ray *R. montagui* and *R. clavata* (northern North Sea) probably continue into the waters west of Scotland and, in the case of *R. montagui,* also into the eastern English Channel. Blonde ray *Raja brachyura* has a patchy distribution, occurring in the southern North Sea (presumably extending to the eastern English Channel) and north-western North Sea (and this stock may extend to north-west Scotland) (Ellis *et al*., 2015).

Dipturus batis, frequently referred to as common skate, has recently been confirmed to comprise of two species being erroneously synonymised in the 1920s (Iglésias *et al*., 2010; Griffiths *et al*., 2010). The smaller species (previously described as *Dipturus flossada* by Iglésias *et al*., 2010) is the common blue skate (*Dipturus batis* (FAO code RJB)) and the larger species may refer to the flapper skate (*Dipturus intermedius* (FAO code DRJ)). The member of the common skate complex present in the northern North Sea is *Dipturus intermedius*, which is generally considered the more vulnerable to fishing pressure. Both species were accepted by Last *et al*. (2016) and are now also accepted in the Catalog of Fishes (Fricke *et al*., 2021) and WoRMS. The distribution and stock boundaries of the two species are uncertain. The larger-bodied flapper skate *Dipturus intermedius* occurs in the north-western North Sea, and this stock is likely the same as occurs of North-west Scotland. The presence and geographical extent of blue skate *Dipturus batis* in this region is uncertain, but this species may have occurred in the southern North Sea historically. Additional work was developed in 2021 in response to WGEF *ToR l*, with further information on *Dipturus* species presented in Section 26.

This section focuses primarily on skates (Rajidae). For the main demersal sharks in this ecoregion, the reader is referred to the relevant chapters for spurdog (Section 2), tope (Section 10), smooth-hounds (Section 21) and lesser-spotted dogfish and other catsharks (Section 25).

15.2 The fishery

15.2.1 History of the fishery

Demersal elasmobranchs are caught as a bycatch in the mixed demersal fisheries for roundfish and flatfish. A few inshore vessels target skates and rays with tangle nets and longlines. For a description of the demersal fisheries see the Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (ICES, 2009a) and the report of the DELASS project (Heessen, 2003).

In 2007, the EC brought in a 25% bycatch ratio (see also Section 15.2.4, footnote 1) for vessels over 15 m. This has restrained some fisheries and may have resulted in misreporting, both of area and species composition.

15.2.2 The fishery in 2020

The landings peaked in the middle of the 1980s and declined steadily thereafter in the North Sea (Figure 15.3.1). Since 2008, the TAC appears to have been restrictive for the fisheries in the North Sea, with landings ranging between approximately 1300–1600 t since 2010. A similar trend is observed for Division 7.d although since 2015, landings have increased by >50% to ~1700 t.

The impact of the COVID-19 pandemic on fishing activity, though so far unquantified, may be assumed depending on national or local restrictions, to have reduced fishing effort in place for at least part of 2020.

15.2.3 ICES Advice applicable

Stock-specific advice for several species/stocks in this region was provided in 2019, see table below (and Section 15.9). Note that for most of stocks ICES provides biennial advice, however, for common skate complex and starry ray quadrennial advice is provided.

ICES stock code	Stock description	ICES Data Category	Advice basis	Previous ICES advice
rjb.27.3a4	Common skate *Dipturus batis-complex* Subarea 4 and Division 3.a	6.3.0	Precautionary approach	ICES has not been requested to provide advice on fishing opportunities in 2019. Last catch advice provided of zero was valid for 2016 to 2019.
rjc.27.3a47d	Thornback ray *Raja clavata* Subarea 4 and divisions 3.a and 7.d	3.2	Precautionary approach	2237 t
rjh.27.4a6	Blonde ray *Raja brachyura* Subarea 6 and divisions 4.a	5.2	Precautionary approach	9 t
rjh.27.4c7d	Blonde ray *Raja brachyura* Divisions 4.c and 7.d	3.2	Precautionary approach	164 t
rjm.27.3a47d	Spotted ray *Raja montagui* Subarea 4 and divisions 3.a and 7.d	3.2	Precautionary approach	301 t
rjn.27.3a4	Cuckoo ray *Leucoraja naevus* Subarea 4 and Division 3.a	3.2	Precautionary approach	139 t
rjr.27.23a4	Starry ray *Amblyraja radiata* Subareas 2, 4 and Division 3.a	3.1.5	Precautionary approach	Zero Valid for 2020 to 2023
raj.27.3a47d	Other skates and rays Subarea 4 and divisions 3.a and 7.d	6.2.0	Insufficient data to provide advice	NA

15.2.3.1 State of the stocks

Since 2012, WGEF provides a qualitative summary of the general status of the major species based on surveys and landings. See sections 15.9 and 15.10 for further details on the assessment methodology of these species.

Common skate complex: Depleted. It was formerly widely distributed over much of the North Sea but is now found only rarely, and only in the northern North Sea. The distribution extends into the west of Scotland and the Norwegian Sea [Note: This perception was based on comparisons of historical and contemporary trawl survey data]. In the last 10 years, catch rates have increased in the IBTS surveys.

R. clavata: Stable/increasing. The distribution area and abundance have decreased over the past century, with the stock concentrated in the south-western North Sea where it is the main commercial skate species. Its distribution extends into the eastern Channel. Survey catch trends in divisions 4.c and 7.d have been increasing since 2009, but have been stable in recent years. The status of *R. clavata* in divisions 4.a-b is uncertain.

R. montagui: Stable The area occupied has fluctuated without trend. Abundance in the North Sea is increasing since 2000. In the eastern Channel a slight increase can be observed during recent years. The stock size indicator has increased during the last decade, and whilst showing a slight decrease in 2020, it has been above the long-term average since 2011.

***A. radiata*:** Decreasing. Survey catch rates increased from the early 1970s to the early 1990s and have decreased since then.

L. naevus: Decreasing. Since 1990 the area occupied has fluctuated without trend. Abundance has decreased since the early 1990s. Catch rates in the IBTS increased during 2004–2012, followed by a marked inter-annual variability between 2013–2016 and a consistent decreasing trend since 2017. Meanwhile abundance has been stable in the BTS Tridens survey.

R. brachyura: Uncertain. This species has a patchy occurrence in the North Sea. It is at the edge of its distributional range in this area. However, several surveys have shown increased catch rates in the last 15 years.

15.2.4 Management applicable

In 1999, the EC first introduced a common TAC for “skates and rays”. From 2008 onwards, the EC has obliged Member States to provide species-specific landings data for the major North Sea species: *R. clavata*, *R. montagui*, *R. brachyura*, *L. naevus*, *A. radiata* and the ‘common skate complex’. WGEF is of the opinion that this measure is ultimately expected to improve our understanding of the skate fisheries in the area.

The TACs (Council Regulation (EU) 2020/123); for skates and rays for the different parts of the area in 2020 are: 1737 t for EU waters of Division 2.a and Subarea 4; 1474 t for Division 7.d; and 47 t for Division 3.a. Some transfer (5%) between the Division 7.d TAC area and the Celtic Seas ecoregion is allowed, which may account for some quota overshoot of the TAC in 7.d.

In 2015 a separate species-specific precautionary TAC for undulate ray (*Raja undulata*) was set within the overall skate TAC for Division 7.d. A special condition applied that up to 5% may be fished in Union waters of 7.e and reported under the following code: (RJU/*67AKD). However, in 2018 France requested ICES to update the advice for undulate ray in divisions 7.d–e and 8.a–b (ICES, 2018). The outcomes of the report contributed to a separate TAC for undulate ray in divisions 7.d and 7.e from 2019 onwards.

The list of prohibited species on EU fisheries regulations (Council Regulation (EU) 2016/72) included the following species within the North Seas ecoregion: white skate *Rostroraja alba* (Union waters of ICES subareas 6–10), thornback ray *Raja clavata* (Union waters of Division 3.a), starry ray *Amblyraja radiata* (Union waters of Divisions 2.a, 3.a and 7.d and Subarea 4) and common skate complex in Union waters of Division 2.a and ICES subareas 3, 4, 6–10.

Year	TAC*	TAC for 2.a and 4	TAC for 7.d	TAC for RJU 7.d-e	TAC for 3.a	Landings**
1999	6060	6060				3997
2000	6060	6060				3992
2001	4848	4848				4011
2002	4848	4848				3904
2003	4121	4121				3797
2004	3503	3503				3237
2005	3220	3220				3238 (3030)
2006	2737	2737				2928 (2845)
2007	2190	2190 (1)				3145 (3141)
2008	1643	1643 (2)				3183 (3025)
2009	2755	1643 (3,4,5)	1044 (i, ii)		68 (a, b)	3126 (3192)
2010	2342	1397 (3,4,5)	887 (i, ii, iii)		58 (a, b)	2893 (2951)
2011	2342	1397 (3,4,5)	887 (i, ii, iii)		58 (a, b)	2707 (2672)
2012	2340	1395 (3,4,5)	887 (i, ii, iii)		58 (a, b)	2813 (2738)
2013	2106	1256 (3,4,5)	798 (ii, iii, iv)		52 (c,d)	2992 (3000)
2014	2101	1256 (4,6,7)	798 (iii,v,vi)		47 (e,f)	2846 (2603)
2015	2227	1382 (4,6,7)	798 (iii, vii, viii)		47 (e)	2520
2016	2326	1313 (6,8,9)	966 (iii, vii, ix)		47 (e)	2688
2017	2488	1378 (6,8,9)	1063 (iii, vii, ix)		47 (e)	2790
2018	2977	1654 (6,8,9,10)	1276 (v,x,xi,xii)		47 (e)	3481
2019	3105	1654(6,8,9,10)	1404(v,x,xi,xiii)	234(1a)	47 (e)	3454
2020	3258	1737(6,8,9,10)	1474(v,x,xi,xiii)	234(1a)	47(e)	3160

***TAC does not include TAC for rju.27.7de for 2019 and 2020.**

****Data from 2005 onwards revised following 2016–2021 Data Call, with previous estimates in brackets. Data contain those species part of this chapter and include landings for *Raja undulata* and *Raja microocellata* declared by Member States in 7.d.**

1) By-catch quota. These species shall not comprise more than 25% by live weight of the catch retained on board.

2) Catches of cuckoo ray *Leucoraja naevus*, thornback ray *Raja clavata*, blonde ray *Raja brachyura*, spotted ray *Raja montagui*, starry ray *Amblyraja radiata* and common skate *Dipturus batis* to be reported separately.

3) Catches of cuckoo ray *Leucoraja naevus*, thornback ray *Raja clavata*, blonde ray *Raja brachyura*, spotted ray *Raja montagui* and starry ray *Amblyraja radiata* to be reported separately.

4) By-catch quota. These species shall not comprise more than 25% by live weight of the catch retained on board. This condition applies only to vessels over 15 m length overall.

5) Does not apply to common skate *Dipturus batis*. Catches of this species may not be retained on board and shall be promptly released unharmed to the extent practicable. Fishers shall be encouraged to develop and use techniques and equipment to facilitate the rapid and safe release of the species.

6) Catches of cuckoo ray *Leucoraja naevus*, thornback ray *Raja clavata*, blonde ray *Raja brachyura* and spotted ray *Raja montagui* to be reported separately.

7) Shall not apply to common skate *Dipturus batis* complex and starry ray *Amblyraja radiata* . When accidentally caught, these species shall not be harmed. Specimens shall be promptly released. Fishermen shall be encouraged to develop and use techniques and equipment to facilitate the rapid and safe release of the species.

8) By-catch quota. These species shall not comprise more than 25% by live weight of the catch retained on board per fishing trip. This condition applies only to vessels over 15 metres' length overall. This condition applies only to vessels over 15 m LOA. This provision shall not apply for catches subject to the landing obligation as set out in Article 15(1) of Regulation (EU) No 1380/2013.

9) Shall not apply to blonde ray *Raja brachyura* in Union waters of 2.a and small-eyed ray *Raja microocellata* in Union waters of 2.a and 4. When accidentally caught, these species shall not be harmed. Specimens shall be promptly released. Fishermen shall be encouraged to develop and use techniques and equipment to facilitate the rapid and safe release of the species

10) Special condition: of which up to 10 % may be fished in Union waters of 7.d (SRX/*07D2.), without prejudice to the prohibitions set out in Articles 13 and 45 of this Regulation for the areas specified therein. Catches of blonde ray (*Raja brachyura*) (RJH/*07D2.), cuckoo ray (*Leucoraja naevus*) (RJN/*07D2.), thornback ray (*Raja clavata*) (RJC/*07D2.) and spotted ray (*Raja montagui*) (RJM/*07D2.) shall be reported separately. This special condition shall not apply to small-eyed ray (*Raja microocellata*) and undulate ray (*Raja undulata*).

(i) Catches of cuckoo ray *Leucoraja naevus*, thornback ray *Raja clavata*, blonde ray *Raja brachyura*, spotted ray *Raja montagui* and starry ray *Amblyraja radiata* to be reported separately.

(ii) Does not apply to common skate *Dipturus batis* and undulate ray *Raja undulata*. Catches of these species may not be retained on board and shall be promptly released unharmed to the extent practicable. Fishers shall be encouraged to develop and use techniques and equipment to facilitate the rapid and safe release of the species.

(iii) Of which up to 5% may be fished in EU waters of 6.a-b, 7.a-c and 7.e-k

(iv) Catches of cuckoo ray *Leucoraja naevus*, thornback ray *Raja clavata*, blonde ray *Raja brachyura*, spotted ray *Raja montagui*, small-eyed ray *Raja microocellata* and starry ray *Amblyraja radiata* to be reported separately.

(v) Catches of cuckoo ray *Leucoraja naevus*, thornback ray *Raja clavata*, blonde ray *Raja brachyura*, spotted ray *Raja montagui* and small-eyed ray *Raja microocellata* to be reported separately.

(vi) Does not apply to common skate complex *Dipturus batis*, undulate ray *Raja undulata* and starry ray *Amblyraja radiata*. Catches of these species may not be retained on board and shall be promptly released unharmed to the extent practicable. Fishers shall be encouraged to develop and use techniques and equipment to facilitate the rapid and safe release of the species.

(vii) Catches of cuckoo ray *Leucoraja naevus*, thornback ray *Raja clavata*, blonde ray *Raja brachyura*, spotted ray *Raja montagui*, small-eyed ray *Raja microocellata* and undulate ray *Raja undulata* to be reported separately.

(viii) Undulate ray not to be targeted, with a trip limit of 20 kg live weight per trip, and catches to remain under an overall quota of 11 t

(ix) Undulate ray not to be targeted, with a trip limit of 40 kg live weight per trip, and to remain under an overall quota of 12 t

(x) of which up to 5 % may be fished in Union waters of 6.a, 6.b, 7.a-c and 7.e-k. This special condition shall not apply to small-eyed ray *Raja microocellata* and to undulate ray *Raja undulata*.

(xi) of which up to 10 % may be fished in Union waters of 2a and 4. This special condition shall not apply to small-eyed ray *Raja microocellata*.

(xii) Undulate ray not to be targeted. The catches shall remain under an overall quota of 19 t.

(xiii) Not applicable to undulate ray *Raja undulata*

1a) This species shall not be targeted in the areas covered by this TAC. This species may only be landed whole or gutted. The former provisions are without prejudice to the prohibitions set out in Articles 14 (16 in 2020 regulations) and 50 (52 in 2020 regulations) of this Regulation for the areas specified therein.

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a) Catches of cuckoo ray *Leucoraja naevus*, thornback ray *Raja clavata*, blonde ray *Raja brachyura*, spotted ray *Raja montagui* and starry ray *Amblyraja radiata* to be reported separately.

b) Does not apply to common skate *Dipturus batis*. Catches of this species may not be retained on board and shall be promptly released unharmed to the extent practicable. Fishers shall be encouraged to develop and use techniques and equipment to facilitate the rapid and safe release of the species.

c) Catches of cuckoo ray *Leucoraja naevus*, blonde ray *Raja brachyura*, spotted ray *Raja montagui* and starry ray *Amblyraja radiata* to be reported separately.

d) Does not apply to common skate *Dipturus batis* and thornback ray *Raja clavata*. Catches of this species may not be retained on board and shall be promptly released unharmed to the extent practicable. Fishers shall be encouraged to develop and use techniques and equipment to facilitate the rapid and safe release of the species.

e) Catches of cuckoo ray *Leucoraja naevus*, blonde ray *Raja brachyura* and spotted ray *Raja montagui* to be reported separately.

f) Does not apply to common skate complex *Dipturus batis*, thornback ray *Raja clavata* and starry ray *Amblyraja radiata*. Catches of this species may not be retained on board and shall be promptly released unharmed to the extent practicable. Fishers shall be encouraged to develop and use techniques and equipment to facilitate the rapid and safe release of the species.

Within the North Sea ecoregion, some of the UK's Inshore Fisheries and Conservation Authorities (IFCAs), formerly Sea Fisheries Committees, have a minimum landing size of 40 cm disc width for skates and rays.

In 2013, Dutch Producer Organisations introduced a minimum landings size of 55 cm (total length) for skates and rays. In addition, to keep landings within the national quota, the POs have implemented landing restrictions which may varying throughout the year to control the quota uptake. Restriction can vary between 40 and 250 kg dead weight. Since 2019, the weekly landings were capped to 160 kg rays per trip. Similarly, Belgium implements a minimum landing size of 50 cm (total length) for skates and rays.

Since 2009, Norway has had a discard ban that applies to skates and sharks, as well as other fish, in the Norwegian Economic Zone. Whilst some discarding of skates is likely to have continued, the precise quantity is unknown.

15.3 Catch data

15.3.1 Landings

The landings tables for all rays and skates combined (tables 15.3.1–15.3.3) were updated. Since 2008, EC member states are required to provide species-specific landings data for the main species of rays and skates and these are collated by stock (Table 15.3.4). These data were all based on data submitted in the 2021 Data Call, with appropriate corrections made, following the recommendations of WKSHARK2 (ICES, 2016), with further updates conducted in 2021.

Figure 15.3.1 shows the total international landings of rays and skates from Division 3.a, Subarea 4, and Division 7.d since 1973. The figure also includes the combined landings from Division 3.a and Subarea 4 plus the TAC for recent years. Data from 1973 onwards are WGEF estimates.

Up to the early 1990s landings of skates in Division 7.d have been relatively stable around 1500 t, thereafter decreasing with lowest levels reported in the early 2000s (<1000 t). During 2007–2017 landings fluctuated around 1300 t. In 2020, landings were over 50% larger compared to 2015 (ca. 1808 t). Contrary to the TAC in the North Sea, in the eastern English Channel the TAC appears less restrictive with estimated landings exceeding it (see also Section 15.2.4). In addition, whereas historically estimated landings in Division 7.d have been much lower than landings Subarea 4, landings in Division 7.d are now above the landings estimated for the North Sea.

Landings of skates in Division 3.a (Skagerrak and Kattegat) are low compared to both other areas. Before the early 2000s landings have been relatively stable around 150 t. Since 2005 landings largely decreased (<50 t) with recent years showing similar levels to earlier years. The TAC appears to have been restrictive in early years though since 2016 estimated landings have been considerably higher than the overall TAC for Division 3.a.

15.3.2 Discard data

Information on discards in the different demersal fisheries is being collected by several Member States, and was submitted to the Expert Group. In 2020, all discard data available in the WGEF accessions folders were collated into a single Microsoft Excel® spreadsheet, with the 2020 data added in 2021.. Whilst discard data are shown per stock from 2009 to 2020 (Table 15.3.5), these should be viewed with caution as further work is required in terms of QA/QC procedures prior to use in the assessments (see Section 1.14).

The estimation of elasmobranch total discards has raised concerns as raising to national catch levels is uncertain, with raising procedures not standardized among member states. Therefore, discard data were deemed unreliable and were not included in the 2021 advice of the skates within the North Sea ecoregion. The main issues concerning discards data are summarized in Section 1.14 of this report.

In addition, discards data collection is likely to have been affected by COVID-19 national restrictions in place during 2020 (e.g. social distancing) hence, a decrease in the number of samples comparatively to previous years may be assumed, though the impact is yet to be quantified.

Length–frequency distributions of discarded and retained elasmobranchs (for the period 1998–2006) were provided by UK-England (ICES, 2006), with updated information in Ellis *et al*. (2010). Silva *et al*. (2012) investigated the UK skate catches, including those from the North Sea, and using observer data, discussed discarding patterns. In general, 50% retention occurred at 49–51 cm total length (L_T) for the main commercial skate species, and nearly all skates larger than 60 cm L_T were retained. *A. radiata* was generally discarded across the entire length range (12–69 cm L_T).

A Dutch (industry) study funded by the European Maritime and Fisheries Fund (2016–2018) was set up to get a more detailed view on the catch composition. Vessels register and retain discards of quota regulated species by haul on board. In the auction, the discards are sorted by species, measured and weighed (Dutch industry report). The sorting process includes skates and rays and results show that, for the Dutch pulse fishery, 80–90% of the rays are discarded, with L_T ranging from 20 to >80 cm for the main commercial species (i.e. *Raja clavata*, *Raja montagui* and *Raja brachyura*). This high discard rate is mainly due to restrictive Dutch quotas for skates and rays.

15.3.3 Quality of the catch data

In 2008, the EC asked Member States to start reporting their landings of skates and rays by (major) species. Compliance with this varies from 0–100% by region and Member State (see Section 15.4.1), with a greatly increased proportion of skates now reported at species-level. The quality of the species-specific data is discussed in Section 15.4.2.

Several nations have market sampling and discard observer programmes that can also provide information on the species composition, although comparable information is lacking for earlier periods. Updated analyses of these data are required.

The ongoing French project “RAIMEST”, conducted by French fisheries regional committees, aims to improve existing knowledge on skate stocks in Division 7.d based on fisher knowledge. This work aims to improve knowledge on functional fishery areas and on the spatial characteristics of skate catches (presence of areas, species distribution, seasonality, individual size, etc). Another goal is to define a correction coefficient to apply to declarative data (logbook) in this area.

15.3.4 Discard survival

Skates and rays were due to come under the European landing obligation (LO) from 1 January 2019 onwards, and given the disparity in quota and actual landings, they were expected to become “choke” species in certain fisheries. As stated in STECF 2014 “Article 15 paragraph 2(b)”, exemptions from the LO are possible for species for which "scientific evidence demonstrates high survival rates". There have since been exemptions made for skates and rays in the North Sea whereby, they can be discarded until the end of 2023 while additional data and information are collected on survivability.

Ellis *et al.* (2017) provided a review of discard survival studies. Skates taken in coastal fisheries using trawls, longlines, gillnets and tangle nets generally show low at-vessel mortality (Ellis *et al.*, 2008a, 2018), though it should be noted that the inshore fleet generally have limited soak times and haul durations. Studies for beam trawlers indicate that just over 70% of skates may survive (Depestele *et al.*, 2014).

The SUMARiS project funded by the INTERREG 2 Seas Programme (2014–2020) provided further information on the vitality, reflex impairment, injury and survival probability of skates discarded in the English Channel and North Sea after being captured onboard commercial fishing vessels using active (beam trawl, otter trawl) or passive (gillnets, trammel nets) fishing gears. A total of 31 trips were organized on-board of French, English and Belgian commercial vessels. The discard survival probability (using immediate and delayed survival estimates (monitored in captivity for 21 days)) for thornback ray and blonde ray discarded by beam trawlers were 54% and 67% respectively. Meanwhile otter trawlers showed overall survival estimates for thornback and blonde ray of 72% and 86%, respectively. For spotted ray and undulate ray by beam trawlers, the overall discard survival estimates was accounted for 27% and 58%, respectively (Van Bogaert *et al.*, 2020).

A Dutch study quantitatively estimated the longer-term discard survival probability of thornback ray. Discard survival was assessed during nine trips with commercial pulse-trawlers, monitoring survival in captivity for 15–18 days (Schram and Molenaar, 2018). The discard survival probability estimates varied among sea trips, resulting in a survival probability estimate of 53% (95% CI 40–65%). Also, during two trips, discard survival probabilities were estimated for spotted ray, resulting in survival probabilities of 21% and 67%. Given the limited numbers of observations per species, estimates should be considered and treated as a first indication of the actual discard survival probability for these species in the 80 mm pulse-trawl fisheries. Further quantitative estimates of longer-term survival are required for a variety of elasmobranchs captured in various European fisheries (Ellis *et al.*, 2018).

15.4 Commercial landings composition

15.4.1 Species and size composition

From 2008 onwards, all EU countries are obliged to register species-specific landings for the main skate species. In the past, only France and Sweden provided landings data by species based on information from logbooks and auctions. However, the accuracy of some of these data was doubtful. The landings for each country have been analysed to determine the percentage of landings that have been reported to species-specific level. It can be seen that this percentage varies between regions and countries. Belgium, France, the Netherlands, UK-England and UK-Scotland demonstrate consistently high levels of species-specific declaration for Subarea 4 and Division 7.d; in 2014 they all declared >75% of their landings in Subarea 4 and Division 7.d to species level. Sweden mainly landed rays and skates from Division 3.a, and 100% of landings were declared at species level. Even though EU nations should declare species-specific landings data for the main species, Denmark, Germany and Norway (Division 3.a and Subarea 4) had lower percentages of landings recorded to species levels, or did not declare any landings to species level. Whilst the Norwegian Reference Fleet provides some information on species composition, this cannot be regarded as representative of the whole Norwegian fishery.

Figure 15.3.2 shows the length–frequency of sampled Dutch skate and ray landings in 2016–2020.

15.4.2 Quality of data

The WG is of the opinion that analyses of data from market sampling and observer programmes can provide reliable data on the recent species composition of landings and discards, and such data should be used to validate and/or complement reported species-specific landings data.

From 2008 onwards, improved species-specific landings are available. Such data can be compared with market sampling and observer programmes to determine whether species identification has occurred correctly. The market sampling programme of the Dutch beam trawl fishery from 2000–2008 demonstrated that *R. montagui* and *R. clavata* are the most common species landed, followed by *R. brachyura* (Table 15.3.5 in ICES, 2020). Since the species-specific landings data were available (from 2008 onwards), it appears that the percentage of *R. montagui* has decreased in the Dutch landings (ICES, 2009b, 2010, 2011a, 2012, 2014) compared with 2000–2007. It is likely that before 2008, misidentification has occurred (especially between *R. montagui* and *R. brachyura*). Misidentification probably affects most nations reporting these two species.

Data quality issues were addressed in more detail at WKSHARK2 (ICES, 2016), and some of the national data, submitted during the 2016 Data Call, were amended accordingly.

Landings of white skate *Rostroraja alba* and *R. microocellata* as reported by France in Subarea 4, Arctic skate *Amblyraja hyperborea* as reported by France in Subarea 4 and Division 7.d, and *D. oxyrinchus* as reported by the UK (England) in Division 7.d are likely the result of misidentifications or coding errors. Furthermore, landings of *L. circularis* reported by Belgium in Division 7.d are unlikely and are suspected to refer to *R. microocellata*, as both species are sometimes known locally as 'sandy ray'. Very low landings (39 kg) of *R. alba* were reported by UK (England) in Subarea 4 and Division 7.d, but the accuracy of this species identification remains unclear.

These examples demonstrate that more robust protocols for ensuring correct identification, both at sea and in the market, and quality assurance of landings data are still needed. The species-specific landings data indicate that some nations still report a considerable proportion of unidentified ray and skate landings or do not report species-specific landing data at all.

In 1981 France reported exceptionally high landings for Subarea 4 and Division 7.d. This is likely to be caused by misreporting. Misreporting may also have taken place in 2007 as a consequence of limited quota and the 25% bycatch limitation.

15.5 Commercial catch-effort data

There are no effort data specifically for North Sea skates and rays.

15.6 Fishery-independent surveys

Time-series of abundance and biomass indices for the most relevant species are available, based on North Sea IBTS, BTS, and CGFS-Q4 surveys. Data were extracted from the DATRAS database or supplied by national laboratories. A description of the surveys is given below. Additional information on all these surveys was collated during WKSKATE (ICES, 2021).

15.6.1 International Bottom Trawl Survey North Sea Q1 (IBTS-Q1) and Q3 (IBTS-Q3)

Fishery-independent data are available from the International Bottom Trawl Survey (IBTS), in winter (Q1) and summer (Q3). An overview of North Sea elasmobranchs based on survey data was presented in Daan *et al.* (2005), with further information collated during WKSKATE on all skates and rays encountered during these surveys (ICES, 2021).

Daan *et al.* (2005) also analysed the time-series of abundance for the major species caught for the period 1977–2004 (see Figure 12.3 of ICES, 2006). *A. radiata* appears to have increased from the late 1970s to the early 1980s, followed by a decline. The reasons for this decline are unknown, but could include changing environmental conditions, multi-species interactions (including with other skates), fishing impacts, or even improved species identification. The same patterns seem to apply to *L. naevus* and *R. montagui*, these species increase in the most recent ten years in the Q1 and Q3 surveys. The 'common skate complex' showed an overall decline, supporting the findings of ICES (2006). Since 2009 an increase of the 'common skate complex' has been observed (Figure 15.6.5). *R. clavata* has been stable, with one outlier in 1991 owing to a single exceptionally large catch (confirmed record), but shows an increasing trend in most recent years (Figure 15.6.3).

15.6.2 Channel groundfish survey

Martin *et al.* (2005) analysed data from the Channel Groundfish Survey (CGFS-Q4) and the Eastern Channel Beam Trawl Survey (UK (BTS-Q3)) for the years 1989–2004. Migratory patterns related to spawning and nursery areas were postulated, with the coast of southeast England an important habitat for *R. clavata*. Updated analyses for this survey were recently published by Martin *et al*. (2010, 2012). CGFS-Q4 continued in 2013, where high indices were noted for *R. clavata* and *R. undulata*. While most species fluctuate without clear trend, *R. clavata* has increased in the last ten years. Information on *R. undulata* is presented in Section 18, as the main part of the stock is considered to occur in Division 7.e. For further information see also WKSKATE report (ICES, 2021).

15.6.3 Beam trawl surveys

The UK beam trawl survey in quarter 3 (BTS-Eng-Q3) started in the late 1980s, although the survey grid was not standardized until 1993 (see Ellis *et al*., 2005a, b and Parker-Humphreys, 2005 for a description of the survey, ICES, 2021). The primary target species for the survey are commercial flatfish (plaice *Pleuronectes platessa* and sole *Solea solea*) and so most sampling effort occurs in relatively shallow water. *Raja brachyura*, *R. clavata*, *R. montagui* and *R. undulata* are all sampled during this survey.

The Dutch beam trawl survey in quarter 3 consists of two parts: the BTS-ISIS-Q3 started in the late 1980s, and the NL BTS Tridens or BTS-TRI-Q3 started in the 1990s. The primary target species for the survey are commercial flatfish (plaice and sole) the BTS ISIS fishes in the Southern North Sea, and the BTS Tridens fishes in the Southern and central North Sea. For more detailed information see also WKSKATE report (ICES, 2021).

The German beam trawl survey in quarter 3 (BTS-GFR-Q3) data are available since the late 2000s (ICES, 2021). Catch rates are generally lower than for the other BTS surveys, with the exception of *A. radiata*.

The Belgian beam trawl survey in quarter 3 (BTS-BEL-Q3) survey data have been uploaded to DATRAS for the following years 2010–2020. Historical data (prior to 2010) are being prepared for uploading to DATRAS. This North Sea survey is organized yearly at the end of August and beginning of September since 1992 on-board of the *RV* Belgica and covers an important area in the south-western part of the North Sea (i.e. Greater Thames estuary and the Wash). The most abundant skate species observed in the survey are thornback ray *Raja clavata* and spotted ray *Raja montagui*. Figure 15.6.8 shows the distribution plots for these species from all BTS surveys in the central-southern North Sea and shows that the highest concentrations (numbers per km^2) are covered by the Belgian BTS. Other elasmobranchs such as lesser-spotted dogfish (*Scyliorhinus canicula*) are caught in large numbers, while smooth-hounds *Mustelus sp.* and blonde ray *Raja brachyura* are also caught, though in smaller numbers. For more detailed information see also WKSKATE report (ICES, 2021).

15.6.4 Index calculations

All survey indices were updated in 2021 following methodologies described in WKSKATE (ICES, 2021), so values may differ from previous advice.

Survey data for the IBTS Q1 and Q3, as well as BTS-ISI-Q3, BTS-TRI-Q3 and BTS-GFR-Q3 were downloaded from DATRAS on 8 June 2021 as CPUE per length per haul. For the CGFS-Q4 and BTS-Eng-Q3, exchange data were downloaded from DATRAS, while the BTS-BEL-Q3 survey data refer to data held within the national database.

For IBTS and BTS, starting from the CPUE (in numbers per hour) per length per haul, indices were calculated for n. hr^{-1}, biomass hr^{-1}, and exploitable biomass h^{-1}. Data for exploitable biomass relate to individuals ≥50 cm total length. This was done by first combining observations for *Dipturus batis* (including for the junior synonym *Dipturus flossada*) and *Dipturus intermedius* as "common skate complex", and to split the observations for *Raja brachyura* for areas 4.a and 4.c. Only

IBTS roundfish areas 1–7 were used when calculating indices for the IBTS-Q1 and IBTS-Q3. Data included in the calculations relate to successfully fished (valid) hauls.

Zero observations were added for all length-haul combinations. he average CPUE per length per ICES statistical was then calculated from the CPUE per length per haul. The CPUE per length per ICES statistical rectangle data was combined with the life history information to obtain CPUE per length per ICES statistical rectangle in numbers per hour and in weight per hour. These were summed across lengths to obtain the overall CPUE per ICES statistical rectangle (numbers and biomass).

For each survey, the annual index value was calculated for the mean catch rate by abundance (mean n.h^{-1}), total biomass (mean kg.h^{-1}) and exploitable biomass (kg.h^{-1}) with associated confidence intervals (95% CI). These values were obtained through the method of bootstrapping (1000 replicates) using 'boot' R package (Davison and Hinkley, 1997; Canty and Ripley, 2021). Input data were the total number (abundance), total biomass and exploitable biomass per statistical rectangle and year (including zero catches) thus, obtaining an annual mean value with a lower and upper confidence limit.

For the BTS-Eng-Q3, survey indices for the whole time series were updated following recommendations from WKSKATE (ICES, 2021). Additionally, calculations are now based on DATRAS exchange data as per ICES (2021) contrary to indices used in the 2019 assessments, with the latter previously described in Silva and Ellis (2019).

The CGFS-Q4indices were calculated using a swept area approach (km^{-2}) for the total abundance, total and exploitable biomass, following the methodology developed during WKSKATE (ICES, 2021). Catches in weight per haul were calculated using a length-weight relationship from McCully *et al.* (2012).

The abundance indices in n. h^{-1} for the different species are presented in tables 15.6.1–15.6.7. The biomass indices in kg.h^{-1} are presented in tables 15.6.8–15.6.14. The exploitable biomass indices in kg.h^{-1} are presented in tables 15.6.15–15.6.21. CGFS-Q4 results are per km^2 instead of per hour in all the tables. Important to note that while CGFS-Q4 2020 data are shown in this report, these should be viewed with caution as survey spatial coverage was reduced due to the lack of dispensation to fish in ICES rectangles 29F1 and 30E9. All indices including the 95% CIs are also given in figures 15.6.1–15.6.7.

In addition to estimating the indices, the annual mean length and range of the individuals caught in the surveys was calculated for the IBTS and BTS surveys (Figure 15.6.9). These can be used to detect possible species misidentifications.

Spatial distribution of the species in the North Sea was estimated by plotting the CPUE information for the IBTS and the BTS surveys in maps (Figure 15.6.10). CGFS-Q4 data were not included in the analysis. These maps were made for 6-year periods, so that changes in spatial distribution can be detected.

15.6.5 Other surveys

French surveys of coastal areas that aim to sample scallops and coastal fish nurseries and communities have bycatch of skates. These surveys include Comor (dedicated to monitoring scallop abundance in 7.d) NourSom (fish nurseries in the Baie de Somme) and NourSeine (fish nurseries in Baie de Seine).

As a part of the biological surveillance of the Penly nuclear power plant, IFREMER surveys the coastal area from Dieppe to the Baie de Somme. Since 1979, the sampling methodology has been standardized, using a stratified sampling scheme relying upon small meshed beam trawls. The surveys are conducted yearly in autumn and juvenile *Raja clavata* are commonly caught (mean length = 28.2 cm L_T; range = 15–45 cm L_T). Catches are mostly in the coastal area between Ault and Cayeux, which may be considered as a nursery ground for the species. Because this survey consists of a long time-series, it would be interesting to describe the evolution of their catches over the last 30 years (Tetard *et al.*, 2015). For more details, see Deschamps *et al.* (1981) and Schlaich *et al.* (2014).

15.7 Life-history information

Elasmobranchs are not routinely aged, although techniques for ageing are available (e.g. Walker, 1999; Serra-Pereira *et al*., 2005). Limited numbers of species have been aged in dedicated studies.

Updated length–weight conversion factors and lengths-at-maturity are available for nine skate species (McCully *et al*., 2012; Silva *et al*., 2013). The length-weight conversions used for the calculations of the fisheries independent biomass indices are given in Table 15.7.1. Three species had conversion factors specific to the North Sea ecoregion, with the lengths at maturity for both sexes of *L. naevus*, and female *R. clavata*, being significantly smaller in the North Sea than the Celtic Seas ecoregion.

Demographic modelling requires more accurate life-history parameters, in terms of age or length and fecundity. For example, recent studies of the numbers of egg-cases laid by captive female *R. clavata* were 38–66 eggs over the course of the egg-laying season (Ellis, unpublished), whereas other studies using oocyte counts and the proportion of females carrying eggs have suggested that the fecundity may be >100.

15.7.1 Ecologically important habitats

Ecologically important habitats for the skates include (a) oviposition (egg-laying) sites (b) nursery grounds; (c) habitats of the rare species, as well as other sites where there can be large aggregations (e.g. for mating or feeding).

Little is known about the presence of egg-laying grounds, although parts of the southern North Sea (e.g. the Thames area) are known to have large numbers of juvenile *R. clavata* (Ellis *et al.*, 2005a) and egg-laying is thought to occur in both the inshore grounds of the Outer Thames estuary and the Wash.

Trawl surveys could provide useful information on catches of (viable) skate egg-cases. This recommendation has therefore been put into the offshore and inshore manuals of the trawl surveys (ICES, 2011b). The Netherlands already collects data on viable elasmobranch egg-cases.

Surveys may be able to provide information on the locations of nursery grounds and other juvenile habitats, and these should be further investigated to identify sites where there are large numbers of 0-groups and where these life-history stages are found on a regular basis.

Little is known about the habitats of the rare elasmobranch species, and further investigations on these are required (e.g. Martin *et al*., 2010; 2012; Ellis *et al*., 2012).

15.8 Exploratory assessment models

Given the lack of longer term species-specific data from commercial fleets and limited biological information, the status of North Sea skates and rays have been evaluated based on survey data, including historical information. Different methods have been explored to assess the stock status of several skate species. Early assessments methods as conducted under the DELASS project (Heessen, 2003) and the SPANdex approach were used to examine changes in abundance and distribution of the four main skate species in the North Sea (*A. radiata*, *L. naveus*, *R. clavata* and

R. montagui). These have been extensively discussed in previous ICES reports (ICES, 2002 and 2007). Only more recent stock assessment developments are hereby presented. GAM analyses of survey trends

In 2016, a GAM analysis focused on *A. radiata* in the IBTS-Q1, IBTS-Q3 and BTS surveys (and also *Scyliorhinus canicula*; see Section 25). The length-based CPUE per haul for the period 1977–2016 were used as input data. These variables were used to predict CPUE in a GAM analysis (Wood, 2006). To estimate the total individuals per length class for the North Sea the predicted spatial distribution of mean CPUE (GAM-outcome) was combined with the swept areas for the NL BTS survey (with the highest catchability estimate in the analysis). The numbers per length were then converted to weights using data from McCully *et al.* (2012). Future work on these analyses could include converting the CPUE indices to numbers per unit area (density estimates) for all surveys (including IBTS), but it should be noted that different ground gears and sweep lengths can be used in some surveys, which may influence catchability.

15.8.1 Population model of starry ray in the North Sea

A minimum population size estimate of starry ray was calculated as part of a request of the Dutch MSC certified trawl fisheries targeting plaice and sole to analyse the impact of these fisheries on the starry ray population (van Overzee *et al.*, 2019).

Data from the IBTS and BTS surveys were downloaded from DATRAS exchange data. Information per haul on numbers caught by length (cm) and tow duration enabled to obtain the total numbers recorded in each haul.

The total number per haul were modelled as a function of year, surface area, survey, and depth, with a spatial or spatio-temporal correlation structure using the statistical package Intergrated Nested Laplace Approximation (INLA) (Rue *et al.*, 2009). This package has the advantage that it can combine, amongst others, spatial and temporal models into one. Detailed information on the model can be found in van Overzee *et al.*, 2019.

The population model shows an increase in the estimated total stock weight in the eighties and early nineties with an estimated stock biomass at 128 667 t. Halfway the nineties and onwards the stock severely declines and stock biomass was estimated to be below 30 000 t since 2010 (Figure 15.8.1). This trend corresponds with ICES assessments conducted by WGEF. It must be noted that the results of this study concern a minimum estimate of the starry population size as the model assumes a catchability of 1, i.e. we assume all fish encountered by the fishing gear are caught.

15.8.2 Exploratory assessment of thornback ray in the eastern English Channel

An exploratory assessment of *R. clavata* in the eastern Channel (Division 7.d) was made using a Bayesian production model, fitted to total catch and survey biomass indices (Marandel *et al.*, 2016). The modelling is applied here to the eastern Channel only, and therefore not to the stock unit considered for advice. This modelling approach suggests that the biomass has been increasing since the 1990s (ICES, 2017). However, the results are conditioned by strong assumptions, in particular the assumed constant intrinsic population growth rate, which may not be true as seen for spurdog *Squalus acanthias* where a clear density dependence in stock fecundity has been observed.

15.8.3 Data limited stock assessment methods applied to North Sea and English Channel

In 2020, two different production models were explored for *Raja clavata*, *Raja montagui* and *Raja brachyura* (Amelot *et al.*, 2021). First, a Surplus Production Model in Continuous Time (SPiCT, Pedersen and Berg, 2017) and a second, a State Space Bayesian Model (SSBM, Marandel *et al.*, 2019). Landings data before 2009 were based on FAO data, no discards data were available for this period. Landings and discards data from 2009–2018 were extracted from WGEF landing and discard tables. Multiple regression was applied to discard data to obtain an effort (time spent at sea) elevation by fleet and species. Abundance indices have been revised, to obtain for all species biomass indices based on CGFS-Q4, BTS and IBTS data. The mean biomass per swept area, species, year survey and statistical rectangle were calculated. Details on the model settings are described in Amelot *et al.* (2021).

For the SSBM, four scenarios were run:

1. A full discard scenario making the hypothesis that discard did correspond to the same ratio of landing before 2009 than after.
2. A 50% discard scenario, making the hypothesis that before 2009 the amount of discard was reduce by half because the TAC was less restrictive compared to recent years.
3. A short time series scenario using only species-specific data from 2009 to 2018
4. A non-depleted hypothesis scenario with an initial biomass (relative to B_{MSY}) up to 0.5 in 1990 instead of 0.3.

Model outputs from SSBM and SPiCT tends to follow the same biomass trajectories. However, SPiCT produces a broader standard error than the SSBM 95% posterior distribution. Initial biomass in 1990 has been estimated to be under 0.5 of the biomass at MSY for all species. The biomass is increasing for all species, even if these stocks' rebuilding dynamics are not going at the same speed. *Raja clavata* present the fastest increase with a final biomass in 2018 of 0.68 B_{MSY} (SPiCT) and 1.02 B_{MSY} (SSBM). The relative biomass for both *Raja brachyura* and *Raja montagui* is larger in the SPiCT analysis compared to the biomass obtained from the SSBM. This could be caused by an underestimation of the carrying capacity by SPiCT compared to the SSBM.

Overall, in both models none of the species are currently exploited above the estimated MSY, when considering landings or the total estimated catches. It should be noted, though, that these models are exploratory models and include assumptions and data which need further exploration and evaluation. In particular, discard data which represent up to half of the total catch for some of the species. Discard values should be improved and standardised for future stock assessments and potential benchmark concerning these stocks.

15.9 Stock assessment

Assessment of the North Sea skate and ray species follow the ICES procedure for data-limited stocks (see Section 15.2.3). The assessments were updated in 2021 for four category 3 stocks based on survey trends (rjc.27.3a47d, rjh.27.4c7d, rjm.27.3a47d, rjn.27.3a4), one category 5 based on landings (rjh.27.4a6), and one category 6 (raj.27.3a47d).

The remaining stocks within this ecoregion are due in 2023, with these being rjr.27.23a4 (category 3) and rjb.27.3a4 (category 6). During the ICES Workshop on the use of surveys for stock assessment and Reference Points for Rays and Skates (WKSKATE; ICES, 2021) the basis of advice from data available to methodology were examined in order to standardize the assessment and the stock size indicators estimation. During this workshop, the group examined stock assessments using different surveys, and different methods for combining surveys. Extensive discussions were undertaken on swept area indices and the raising methodology to either geographical area covered by an individual survey, to the stock unit, to ICES Division. Methods for deciding how and whether surveys should be used were agreed during the meeting (ICES, 2021).

The following outcomes of WKSKATE have been applied to the North Sea stock assessments in 2021:

- The IBTS-Q1 and IBTS-Q3 are to be aggregated by averaging the indices in a given year, prior to normalizing the indices over their long-term mean.
- *Leucoraja naevus* in 3.a and 4. It was considered that the IBTS-Q1 and IBTS-Q3 surveys should be used as the basis for the Category 3 assessment.
- *Raja clavata* in 3.a, 4 and 7.d. The surveys with a good spatial coverage of the stock unit are the four surveys used in the 2019 assessment (IBTS-Q1, IBTS-Q3, BTS-Eng-Q3 and CGFS-Q4). The BTS-Bel-Q3 was added as a fifth survey given it also covers parts of the stock unit in both 4.c and 7.d. The stock size indicator is therefore based on five surveys and based on exploitable biomass.
- *Raja montagui* in 3.a, 4 and 7.d. It was considered that the IBTS-Q1 and IBTS-Q3 surveys should be the only surveys used in the 2021 assessment. Whilst BTS-Eng-Q3 would cover part of the stock unit in 7.d and was used in the 2019 assessment, given that the stock size indicator is based on exploitable biomass (individuals ≥50 cm total length), data for this survey were deemed too limited to be used in the assessment. Thus, stock size indicator in the 2021 assessment refer only to surveys covering Subarea 4.
- *Raja brachyura* in 6 and 4.a. This species is not sampled effectively in many trawl surveys. Whilst the current surveys are unlikely to provide stock-size indicators that would be sufficiently robust to support Category 3 assessments and ICES advice on fishing opportunities, further work should be undertaken. Available trawl survey data should be examined with a view to providing alternative metrics that may help inform a more qualitative perception of stock status.
- *Raja brachyura* in 4.c and 7.d. The CGFS-Q4 is currently used in the assessment and, whilst there is a clear sign of improving status in recent years, catch rates are variable. Catch rates of *R. brachyura* in IBTS-Q1 and IBTS-Q3 show a similar recent increase, but the underlying data are highly variable, with a large number of zero hauls recorded. Further studies to develop more robust indices for this stock are required.

15.10 Quality of assessments

Analyses of survey data for *R. clavata* undertaken by ICES (2002; 2005) may have been compromised by misidentifications in submitted IBTS data, and so the extent of the decline in distribution reported in these reports may be exaggerated. The distribution of *R. clavata* in the southern North Sea has certainly contracted to the south-western North Sea, and they are now rare in the south-eastern North Sea, where they previously occurred (as indicated by historical surveys). The perceived decline in catches in the north-eastern North Sea may have been based, at least in part, on catches of *A. radiata*. Excluding questionable records from analyses still indicates that the area occupied by *R. clavata* has declined, with the stock concentrated in the south-western North Sea, with catch trends in Division 4.c more stable/increasing in recent times (ICES, 2017).

Previous issues encountered during the 2019 WG for BTS-Eng-Q3 and CGFS-Q4 have since been resolved (ICES, 2019), with new indices produced for both surveys following methodology developed during WKSKATE (ICES, 2021). Whilst the results may differ from previous assessment in 2019 these do not change the perception of stock status.

While the use of a swept area approach for *R. clavata* was agreed at WKSKATE (ICES, 2021), the group decided further development of swept area indices is required. During the meeting a subgroup convened to discuss data quality issues relating to swept area (i.e. width of the gear and distance travelled) as well as most appropriate approaches to raising swept area estimates. The group decided more work is needed and is to be coordinated intersessionally before WGEF is to apply the swept area approach. Nevertheless, future assessments of *R. clavata* or other stocks (e.g. spotted ray (*R. montagui*) in Subarea 4 and in Divisions 3.a and 7.d) for which this approach may be relevant should consider the use of swept-area indices.

Note that for the CGFS-Q4 survey, the 2020 sampling was restricted to French waters, with the ICES rectangles 29F1 and 30E9 not sampled thus, the values derived for 2020 were deemed not representative and were not considered in the assessment. Therefore, the missing data approach for category 3 and 4 stocks was applied, where only data up to 2019 are included in the combined stock size indicator. A 2 over 5 ratio was still applied. For the skate stocks, where the CGFS-Q4 was the only available survey (e.g. rjh.27.4c7d), the ratio was calculated considering 2020 was missing. This meant that the last 2-year average would be based on the one available estimate for 2019.

15.11 Reference points

No reference points have been proposed for *R. clavata* or other skate stocks in this ecoregion.

15.12 Conservation considerations

Both members of the 'common skate complex' are considered 'Critically Endangered by the IUCN, and '*D. batis*', *R. montagui*, and *R. clavata* are all on the OSPAR list of Threatened and Declining species. However, WKSTATUS considered that both *R. montagui* and *R. clavata* do not continue to justify inclusion in the OSPAR list (ICES, 2020).

Various elasmobranchs are contained in the Swedish Red List (Gärdenfors, 2010), with *R. lintea* considered Near Threatened, *R. clavata* and rabbit fish *Chimaera monstrosa* considered Endangered, and '*D. batis'* considered Regionally Extirpated.

The Norwegian Red List (Gjøsæter *et al*., 2010) includes various skates. '*D. batis*' (complex) is considered Critically Endangered, and *B. spinicauda*, *D. nidarosiensis* and *L. fullonica* are all considered Near Threatened.

15.13 Management considerations

Skates are usually caught in mixed fisheries for demersal teleosts, although some inshore longline and gillnet fisheries target *R. clavata* in seasonal fisheries in the south-western North Sea. *Raja brachyura* may be locally and seasonally important for some inshore fisheries.

Up to 2008, skates were traditionally landed and reported in mixed categories such as "skates and rays". For assessment purposes, species-specific landings data are essential. Species-specific reporting for the main skate species has been required since 2008. An increasing proportion of skate landings are now reported to species and, whilst there are some inconsistencies, the overall proportions broadly correspond with what would be expected, given survey information. Nevertheless, some doubt exists as to the quality of some of the data provided, particularly the distinction between *R. montagui* and *R. brachyura.* Continued species-specific reporting is required, and further scientific sampling of commercial catches (to validate species-specific landings) and training are required.

A TAC for skates was first established for Union waters of Division 2.a and Subarea 4 (combined) in 2009. Since 2009, there have been three separate TAC areas in this ecoregion: Union waters of Division 2.a and Subarea 4 (combined); Division 3.a; and Division 7.d.

Landings have been at or above the TAC since 2006 (but slightly above in Division 7.d, possibly due to transfer between 7.d and 7.e) (Figure 15.3.1) and may now be restrictive for some fisheries. Since its introduction, the TAC has gradually been reduced, which may have induced regulatory discarding. In recent years (2016–2020), the TAC has increased slightly.

At-vessel mortality is low for inshore trawlers in the south-western North Sea, as tow duration tends to be relatively short and longline fisheries also have low at-vessel mortality (Ellis *et al.*, 2008a, b, 2018). At-vessel mortality in gillnets may also be low, depending on soak-time. A study on survival from beam trawlers indicated survival of >70% for skates (Depestele *et al.*, 2014). Discard survival probability varies significantly according to species and gear combination and ranged between 27%86%. Fish condition, individual length and sorting time strongly affected both short and medium-term survival (Van Bogaert *et al.*, 2020). In pulse-trawlers the long-term discard survival probability for thornback ray was estimated to be 53% (Schram and Molenaar, 2018).

Effort restrictions and high fuel prices have resulted in reduced effort, but can also result in using different gears with different catchabilities for skates. Also, some fisheries may redirect effort to fishing grounds closer to port, which may affect more coastal species, such as *R. clavata* in the Thames estuary and in the Wash in the south-western North Sea.

Current TAC regulations have a condition so that "*up to 5%* [of the TAC for Union waters of 6.a-b, 7.a–c and 7.e–k] *may be fished in Union waters of 7.d*". Whilst it is pragmatic allowing vessels in the English Channel (7.d–e) to transfer quota between these divisions, further studies to examine the implications of this needs to be evaluated. For example, 5% of the overall 2014 quota for 6.a-b, 7.a–c and 7.e–k (8032 t) is 401.6 t, which is more than half of the 2014 TAC for 7.d (798 t). Whilst this is a theoretical maximum and unlikely to be realised, further studies of this issue are required.

15.14 References

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Table 15.3.1. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Total landings of skates (Rajidae) in ICES Division 3.a (in tonnes). Note blank = no data reported; that "0" indicates landings <0.05. Data from 2005 onwards from the 2016–2021 Data Call.

Year	DK	DE	NL	NOR	SE	Total
1999	11			208	2	221
2000	41			123	2	166
2001	56			154	12	222
2002	22			159	13	194
2003	36			163	9	208
2004	129			85	20	234
2005	65	0.3		94	10	170
2006	25	0.5	0	51	18	95
2007	8	0.4	0	13	11	33
2008	4	0.1		23	6	33
2009	12			33	2	47
2010	12			24	10	45
2011	43	0		25	3	71
2012	16	0.1		28	3	47^
2013	18	0.1		50	6	74^
2014	14	0		39	3	56
2015	27	0	0.3	32		60
2016	40		0	50	0	90
2017	72	0		55	0.2	128
2018	157	0	0.1	52	0.1	209
2019	122		0.3	34	2	159
2020	108		2	31	0.3	141

^ Data revised in 2021.

Table 15.3.2. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Total landings of skates (Rajidae) in ICES Subarea 4 (in tonnes). Note: blank = no data reported; "0" indicates landings <0.05. Data from 2005 onwards from the 2016–2021 Data Call. Data include accepted lower quantities of landings for *Raja microocellata* and *Raja undulata* declared by Member States in 4.c.

Year	BEL	DK	FRA	DE	NLD	NOR	SE	UK	Total
1999	336	45	41	16	515	152		1583	2688
2000	332	93	31	23	693	161		1376	2709
2001	370	65	61	11	834	173		1298	2812
2002	436	34	62	22	805	83		1353	2794
2003	323	33	36	21	686	113		1278	2490
2004	276	25	37	17	561	77		1062	2055
2005	350	25	60	28	493	87	0	833	1876
2006	346	28	77	16	530	98	0	732	1826
2007	261	29	66	17	659	71	0	704	1807
2008	387	24	72	29	506	97	0	762	1878
2009	303	30	80^	22	379	121	0	666^	1601^
2010	310	30	100^	32	390	105	0	662	1631^
2011	237^	38	60^	19	212	56	0.5	788	1410^
2012	188^	21	48	17	431	69	0	662	1436^
2013	214^	45	53	25	312	74	0	804	1526^
2014	199^	44	52	32	225	88	0	778	1419^
2015	246^	40	22	25	274	62		666	1335^
2016	184^	41^	39	50	281	69	0	664^	1328^
2017	176	40^	38	42	287	91	0	700	1373^
2018	178	56^	38	55	363	118	0	809	1617
2019	148	70^	47	53	320	128	0	768	1535
2020	95	34	57	52	372	106	0	496	1211^

^ Data revised in 2021.

Table 15.3.3. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Total landings of skates (Rajidae) in ICES Division 7.d (in tonnes). Note: blank = no data reported; "0" indicates landings <0.05. Data from 2005 onwards from the 2016–2021 Data Call. Data include landings of *Raja microocellata* and *Raja undulata* declared by Member States in 7.d.

Year	BEL	FRA	IRL	NLD	UK	Total
1999	93	558			437	1088
2000	69	693			355	1117
2001	79	729			169	977
2002	113	725			140	978
2003	153	796			186	1135
2004	96	695			157	948
2005	100	940	0	9	144	1193
2006	113	738		12	144	1007
2007	158	926		18	204	1305
2008	171	880		12	209	1272
2009	119	1185		10	164	1478
2010	107	960		10^	139	1216
2011	106	956		12	151	1225
2012	105	1040		14	172	1331
2013	131	1065		4	193	1392
2014	112	1060		6	193	1371
2015	115	868		3	146	1132
2016	136	941		8	200	1285
2017	141	924		9	236	1310
2018	166	1186^		25	301	1677
2019	183	1295		31	308	1817
2020	207	1302		43	311	1863

^ Data revised in 2021.

Table 15.3.4. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Landings per stock and country in the North Seas ecoregion (Subarea 4 and divisions 3.a and 7.d) (in tonnes). Note: blank = no data reported; "0" indicates landings <0.05; ^ data revised in 2021

Raj.27.3a47d										
Year	**BEL**	**DE**	**DK**	**FRA**	**GBR**	**IRL**	**NLD**	**NOR**	**SE**	**Total**
2005	450.1	28.3	90.0	754.9	977.2	0.1	501.5	180.2	10.4	2992.7
2006	458.4	16.6	53.0	675.1	876.2		541.8	149.2	17.7	2788.0
2007	417.2	17.6	37.0	735.4	907.8		677.1	84.3	11.2	2887.5
2008	186.5	29.3	28.0	806.7	720.9		66.4	119.6	6.4	1963.9
2009	128.0	22.1	40.0	578.1	412.9		4.5	153.6	2.0	1341.2
2010	137.3	32.4	39.0	444.7	210.1		5.2	123.0	9.5	1001.2
2011	93.5	19.0	77.0	378.7	144.3		5.8	80.0	2.8	801.1
2012	50.9	16.8	37.0	248.9	107.5		25.3	95.2	1.6	583.0
2013	15.9	25.1	60.0	107.1	99.0		12.1	120.4	4.2	443.8
2014	25.1	32.2	49.0	40.5	81.5		9.5	126	3.2	366.9
2015	31.3	25.1	62.6	17.5	33.2		5.8	94.7		270.4
2016	39.6	11.7	74.8	19.9	27.6		2.4	119.1	0	295.1
2017	35.9	8.4	88.2	25.6	32.2		1.8	146.0	^	338.2^
2018	4.3	9.8^	169.8	21.0^	31.2			169.4		405.5^
2019	0.7	2.6	117.3	9.7	46.1			162.3	2.6	341.4
2020	1.1	0.2	76.1	10.0	19.1			137.1	0.4	244.0

rjb.27.3a4								
Year	**BEL**	**DE**	**DK**	**FRA**	**GBR**	**NLD**	**SE**	**Total**
2005				0.7				0.7
2006				0.1			0.4	0.5
2007				0.1			0	0.1
2008	0			0.2	0.5	0		0.8
2009			2.0	0.2	7.0			9.2
2010	0		2.0	0.5	0.7		0.5	3.7
2011			1.0	0.1	4.2	0	0.7	6.0
2012					1.8	0.5	1.4	3.7
2013				0.0	1.0		1.9	2.9
2014				0.0	0.3			0.3
2015			0.7		0.3			1.0
2016			2.0		0.3	0	0	2.4
2017			15.7	0.1	0.7	0	0	16.5
2018	0		25.3		0.4^	0.5		26.0
2019			14.8		0	0.2	0	15.1
2020		0	7.3		0.7	0.5	0	8.6

rjc.27.3a47d									
Year	BEL	DE	DK	FRA	GBR	NLD	NOR	SE	Total
2005				196.4	0		0.8		197.2
2006				107.8				0	107.9
2007	0.6			155.3	0			0	155.9
2008	214.2			90.1	208.9	196.6	0.0		709.7
2009	153.9			461.9	334.9	178.1			1128.8
2010	175.6		1.0	541.1	409.1	203.2	5.9		1335.8
2011	163.9		1.0	533.8	485.2	97.0	0.5	0	1281.6
2012	154.3			769.0	477.5	186.4	2.0	0	1589.2
2013	200.7		2.0	940.5	572.7	149.0	3.3		1868.3
2014	205.9		8.0	988.6	570.8	130.8	1.2		1905.3
2015	219.1		3.7	814.2	447.3	160.6			1644.8
2016	195.8	33.8	2.7	890.5	518.0	185.2		0	1825.9^
2017	173.5	27.3	1.1	829.3	595.9	162.7		0^	1790^
2018	193.3	33.0	1.7	1117.1	663.8	211.3^		0	2220.4^
2019	192.2	36.9	0.1	1190.8	589.4	194.1		0	2203.5
2020	169.1	41.5	3.7	1237.1	488.4	282.7			2222.6

rjm.27.3a47d							
Year	BEL	DE	DK	FRA	GBR	NLD	Total
2005				41.9	0.0		41.9
2006				25.9			25.9
2007	0.1			93.4	0.0		93.5
2008	38.7			46.2	9.4	240.4	334.7
2009	34.6			127.8	28.3	199.7	390.3
2010	35.1			32.2	56.2	182.3	305.8
2011	31.2			30.8	93.2	108.0	263.2
2012	10.0			25.5	82.2	180.0	297.7
2013	11.6			28.2	127.1	119.4	286.2
2014	4.3		1.0	35.7	106.7	66.4	214
2015	9.4		0.1	15.2	123.6	76.9	225.3
2016	9.9	4.1		15.7	117.2	76.3	223.2
2017	15.4	5.9		36.8	113.7	87.4	259.2
2018	27.1	10.8		16.0	188.6	112.5	356^
2019	40.9	12.5	0.1	22.5	174.3	92.6	342.8
2020	17.0	9.7	0.6	25.2	35.6	86.8	174.9

rjh.27.4c7d							
Year	**BEL**	**DE**	**DK**	**FRA**	**GBR**	**NLD**	**Total**
2005							
2006							
2007	0.2						0.2
2008	115.8				22.4	14.6	152.8
2009	104.3			12.9	35.1	5.9	158.2
2010	63.1			20.9	38.9	9.9	132.8
2011	45.5			26.9	58.5	12.8	143.6
2012	72.4			22.7	45.3	53.1	193.6
2013	109.1			23.9	70.6	35.7	239.4
2014	69.3			30.4	57.4	24.3	181.4
2015	90.2			30.9	36.1	33.8	191.1
2016	65.2	0		35.6	21.6	24.8	147.3
2017	75.1	0		50.2	29.4	43.9	198.6
2018	107.8	0		46.3	32.3	64.6	251.2
2019	83.4	1		75	27.6	64.8	251.8
2020	101.1	0		59.5	33.3	46.4	240.8

rjh.27.4a6							
Year	**BEL**	**DK**	**ES**	**FRA**	**GBR**	**IRL***	**Total**
2005							
2006							
2007							
2008					6.8		6.8
2009	0		0	0.9	5.2	0	6.4
2010	0				6.7	3.7	10.4
2011					16.6	0.9	17.5
2012					4.0	1.4	5.4
2013					0.5	23.6	24.1
2014				0.6	0.7	8.6	10.0
2015		0		0.8	3.4	9.3	13.6
2016				0.6	2.3	10.9	13.8
2017				0	1.1	5.4	6.8
2018				1.2	2.8	23.0	27.0
2019				0.8^	1.5^	33.2	35.4^
2020	0			0.6	0	20.4	21.5

***Landings of Ireland are declared coming out of Subarea 6.**

rjn.27.3a4							
Year	**BEL**	**DE**	**DK**	**FRA**	**GBR**	**NLD**	**Total**
2005							
2006							
2007							
2008	2.5			0	0	0	3.3
2009	1.0			1.1	4.6	0	7.1
2010	3.7			1.0	81.2	0	86.3
2011	5.0		2.0	1.0	143.1		151.1
2012	1.1			0.5	115.5		117.1
2013	0.6		1.0		122.6	0	124.4
2014	0.5			0	151.7	0	152.5
2015	3.1		0		169.0		172.5
2016	0		1.4	0	167.6	0	169.7
2017	0		7.4	0	154.3		162.4
2018	0		14.6	0	179.6		194.5
2019	0		56.8	1.1	201.6		259.7
2020	0		53.8	0	176.1		230.5

rjr.27.23a4								
Year	**BEL**	**DE**	**DK**	**FRA**	**GBR**	**NLD**	**SE**	**Total**
2005								
2006								
2007								
2008	0							0.1
2009					0			0.1
2010					0			0
2011				1.2			0	1.3
2012					0	0		0.3
2013				0	0			0
2014	0			0	0			0
2015				0				0
2016				0				0
2017			0	0				0.1
2018		0	1.1	0.9	0			2.4
2019			2.6	0.6	0			3.2
2020				1.2	0	0.1		1.3

Table 15.3.5 Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Discards per stock and country in the North Seas ecoregion (Subarea 4 and divisions 3.a and 7.d) (in tonnes). "0" indicates discards <0.05. Values to be viewed with caution as further QA/QC procedures still required prior to use in assessment (see Section 15.3.2).

raj.27.3a47d										
Year	**BEL**	**DE**	**DK**	**FRA**	**GBR**	**IRL**	**NLD**	**NOR**	**SE**	**Total**
2009										
2010										
2011										
2012										
2013										
2014			0							0
2015										
2016				778						778
2017				827						827
2018			8.0						4.5	12.6
2019			10.9						1.7	12.5
2020	7.6		2.4							10

rjb.27.3a4								
Year	**BEL**	**DE**	**DK**	**FRA**	**GBR**	**NLD**	**SE**	**Total**
2009			18.3					18.3
2010			13.3					13.3
2011			28.9					28.9
2012			100.7					100.7
2013			34.8					34.8
2014			1.6					1.6
2015			4.4					4.4
2016			8.2					8.2
2017			2.3					2.3
2018			15.3				0.6	15.9
2019			2.7				1.9	4.6
2020			5.2					5.2

rjc.27.3a47d									
Year	BEL	DE	DK	FRA	GBR	NLD	NOR	SE	Total
2009					89.9				89.9
2010					446.4				446.4
2011			1.4	78.2	423.8	249.6			753.0
2012			1.6	128.3	199.1	187.2			516.2
2013	139.5		2.1	265.6	175.5	110.2			692.8
2014	238.7		1.6	62.9	153.5	289.6			746.2
2015	185.4		22.1	313.0	227.1	214.1			961.8
2016	143.2	5.3	21.0	402.3	156.5	165.0			893.3
2017	243.4		6.4	429.2	291.4	526.9			1497.2
2018	119.6	35.9	9.9	282.7	60.5	329.3		15.0	852.8
2019	228.9	32.7	8.3	391.4	440.2	578.6		12.9	1692.9
2020	191.5	9.9	38.2	507.9	85.7	417.6			1250.8

rjm.27.3a47d							
Year	BEL	DE	DK	FRA	GBR	NLD	Total
2009					10.9		10.9
2010					283.4		283.4
2011				17.6	7.0	364.2	388.9
2012				0	3.5	274.1	277.9
2013	7.6			2.4	17.6	290.2	317.9
2014	2.3			16.2	12.1	386.5	417.1
2015	4.7			10.1	42.5	282.9	340.2
2016	10.9			4.2	181.5	422.5	619.1
2017	14.0	0		33.2		935.1	982.3
2018	45.7	59.3	1.0	302.4	15.3	780.1	1203.8
2019	20.9	90.1	0.9	22.4	6.0	415.8	556.1
2020	43.0	32.4	0.6	12.7	8.7	457.8	555.1

rjh.27.4c7d							
Year	BEL	DE	DK	FRA	GBR	NLD	Total
2009					5.6		5.6
2010					35.3		35.3
2011				5.4	0.5	252.7	258.7
2012			0	7.9	64.6	22.3	94.7
2013	16.9			3.8	5.4	18.7	44.9
2014	22.2			14.8	33.9	36.6	107.6
2015	43.7			9.5	3.2	91.8	148.2
2016	44.9		0	8.0	11.6	31.5	96.1
2017	25.1			20.0		191.5	236.6
2018	28.5			18.4		168.1	215.0
2019	28.0			12.3		207.6	247.9
2020	36.6				0	46.5	83.1

rjh.27.4a6							
Year	BEL	DK	ES	FRA	GBR	IRL	Total
2009						4.2	4.2
2010						2.2	2.2
2011						2.4	2.4
2012						0	0
2013						5.7	5.7
2014						0.6	0.6
2015						0.9	0.9
2016							
2017						0	0
2018		0				3.6	3.8
2019						0.5	0.5
2020						0.6	0.6

rjn.27.3a4								
Year	BEL	DE	DK	FRA	GBR	NLD	SE	Total
2009			0		11.1			11.6
2010					1.3			1.3
2011			0		5.6			5.8
2012					11.1	36.3		47.3
2013	0				5.3			5.6
2014	0		0.9		25.7	4.3		31.0
2015			1.2		22.7			23.9
2016	0		3.6		1.9	1.2		7.0
2017	1.0		0.8	7.2				8.9
2018			12.6	15.7	1.5	7.1	0	37.2
2019	0		7.2	269.6	1.9			278.9
2020				12.0	218.1			230.1

rjr.27.23a4								
Year	BEL	DE	DK	FRA	GBR	NLD	SE	Total
2009			3245.4					3245.4
2010			2453.7					2453.7
2011			3612.0					3612.0
2012			3548.8					3548.8
2013			1083.3					1083.3
2014			1767.3					1767.3
2015			2979.6					2979.6
2016			1317.3					1317.3
2017			1017.1	1.3		139.0		1157.4
2018			488.8	4.7		92.7	95.8	682.0
2019			622.6			66.6	122.6	811.7
2020			420.3		609	85.5		1114.9

Table 15.6.1. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Time-series of abundance estimates (n.h^{-1}) for *Amblyraja radiata* (all individuals). Information obtained from IBTS-Q1, IBTS-Q3 (roundfish areas 1–7) and several BTS surveys in the period 1987–2020. Data extracted from DATRAS. Time-series updated in 2021.

Year	IBTS-Q1	IBTS-Q3	BTS-ISI-Q3	BTS-TRI-Q3	BTS-GFR-Q3
1987	7.095	NA	NA	NA	NA
1988	2.670	NA	0.621	NA	NA
1989	6.612	NA	0.382	NA	NA
1990	4.891	NA	1.472	NA	NA
1991	4.171	9.449	0.447	NA	NA
1992	7.528	2.463	0.184	NA	NA
1993	12.232	1.773	0.053	NA	1.322
1994	3.913	1.994	0.045	NA	7.743
1995	8.526	1.930	0.188	NA	1.325
1996	7.111	2.227	0.118	20.452	NA
1997	5.518	1.822	0.000	16.279	11.542
1998	5.692	2.180	0.000	23.308	0.898
1999	6.473	3.134	0.143	34.191	15.780
2000	7.914	3.215	0.000	34.000	NA
2001	11.358	6.520	0.037	21.217	17.531
2002	4.353	3.307	0.031	25.459	0.865
2003	4.543	3.722	0.067	18.972	0.517
2004	3.795	2.143	0.071	20.762	0.375
2005	4.022	2.270	0.303	19.343	0.098
2006	1.992	2.499	0.179	13.729	NA
2007	3.180	3.794	0.000	14.557	17.412
2008	2.521	2.646	NA	15.174	15.396
2009	0.982	2.967	0.897	14.759	10.693
2010	0.945	1.939	0.000	15.479	9.950
2011	1.012	2.435	0.000	13.842	8.783
2012	1.502	2.014	0.091	13.239	18.278
2013	0.684	1.367	0.069	13.379	13.372
2014	1.088	1.630	0.817	12.298	1.462
2015	1.605	2.223	0.172	10.101	9.518
2016	1.137	2.059	0.469	8.315	11.737
2017	1.255	1.453	NA	4.059	8.463
2018	0.326	1.528	NA	4.293	6.158
2019	0.564	1.238	NA	6.184	5.250
2020	0.272	1.119	NA	5.531	6.240

Table 15.6.2. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Time-series of abundance estimates (n.h^{-1}) for *Leucoraja naevus* (all individuals). Information obtained from IBTS-Q1, IBTS-Q3 (roundfish areas 1–7) and several BTS surveys in the period 1987–2020. Data extracted from DATRAS. Time-series updated in 2021.

Year	IBTS-Q1	IBTS-Q3	BTS-ISI-Q3	BTS-TRI2-Q3
1987	0.131	NA	NA	NA
1988	0.526	NA	0.035	NA
1989	0.550	NA	0.000	NA
1990	0.575	NA	0.000	NA
1991	0.549	0.316	0.000	NA
1992	0.764	0.439	0.000	NA
1993	0.903	0.144	0.000	NA
1994	0.586	0.186	0.000	NA
1995	0.611	0.138	0.000	NA
1996	0.499	0.157	0.000	0.905
1997	0.262	0.235	0.000	1.302
1998	0.478	0.113	0.000	3.115
1999	0.398	0.436	0.000	3.841
2000	0.556	0.371	0.000	2.169
2001	0.332	0.589	0.000	1.478
2002	0.449	0.428	0.000	2.840
2003	0.278	0.373	0.000	3.015
2004	0.306	0.362	0.000	0.972
2005	0.308	0.433	0.000	1.659
2006	0.397	0.535	0.000	1.420
2007	0.487	0.367	0.000	2.507
2008	0.420	0.795	NA	4.400
2009	0.401	0.700	0.000	2.013
2010	0.459	0.855	0.000	0.576
2011	0.489	0.798	0.000	0.958
2012	0.464	0.920	0.000	1.013
2013	0.804	0.623	0.000	1.220
2014	0.525	0.486	0.000	1.465
2015	0.911	0.543	0.000	0.702
2016	0.545	0.541	0.000	1.333
2017	0.891	0.770	NA	1.772
2018	0.393	0.744	NA	1.827
2019	0.508	0.578	NA	1.606
2020	0.364	0.461	NA	1.615

Table 15.6.3. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Time-series of abundance estimates (n.h^{-1}) for 'common skate complex' (all individuals). Information obtained from IBTS-Q1, IBTS-Q3 (roundfish areas 1–7) and BTS-TRI-Q3 in the period 1987–2020. Data extracted from DATRAS. Time-series updated in 2021.

Year	IBTS-Q1	IBTS-Q3	BTS-TRI-Q3
1987	0.000	NA	NA
1988	0.013	NA	NA
1989	0.000	NA	NA
1990	0.000	NA	NA
1991	0.026	0.007	NA
1992	0.000	0.000	NA
1993	0.019	0.000	NA
1994	0.000	0.000	NA
1995	0.000	0.000	NA
1996	0.020	0.000	0.000
1997	0.000	0.000	0.000
1998	0.006	0.014	0.000
1999	0.013	0.033	0.000
2000	0.000	0.000	0.000
2001	0.000	0.000	0.000
2002	0.007	0.021	0.000
2003	0.000	0.000	0.000
2004	0.000	0.000	0.000
2005	0.006	0.013	0.105
2006	0.000	0.005	0.000
2007	0.051	0.000	0.000
2008	0.006	0.026	0.000
2009	0.013	0.013	0.000
2010	0.044	0.000	0.000
2011	0.056	0.033	0.000
2012	0.000	0.133	0.160
2013	0.093	0.062	0.000
2014	0.039	0.067	0.086
2015	0.063	0.013	0.080
2016	0.080	0.064	0.000
2017	0.055	0.100	0.076
2018	0.157	0.030	0.000
2019	0.135	0.108	0.000
2020	0.220	0.055	0.020

Table 15.6.4. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Time-series of abundance estimates for *Raja clavata* (all individuals). Information obtained from IBTS-Q1, IBTS-Q3 (roundfish areas 1–7), several BTS surveys and eastern Channel CGFS-Q4 in the period 1987–2020. Data extracted from DATRAS, except for BTS-BEL-Q3 (extracted from the National database). Estimates are in n.h^{-1} for all surveys except CGFS-Q4 where n.km^{-2} are used. Time-series updated in 2021.

Year	IBTS-Q1	IBTS-Q3	BTS-ISI-Q3	BTS-ENG-Q3	BTS-TRI-Q3	BTS-GFR-Q3	BTS-BEL-Q3	CGFS-Q4
1987	0.926	NA	NA	NA	NA	NA	NA	NA
1988	0.219	NA	0.023	NA	NA	NA	NA	NA
1989	0.931	NA	0.741	NA	NA	NA	NA	NA
1990	0.631	NA	0.982	NA	NA	NA	NA	NA
1991	19.181	0.457	0.000	NA	NA	NA	NA	NA
1992	1.237	0.646	0.579	NA	NA	NA	NA	NA
1993	0.355	0.571	0.000	3.060	NA	0.000	NA	15.906
1994	0.379	0.065	0.030	2.759	NA	0.000	NA	18.878
1995	0.083	0.015	0.083	1.632	NA	0.000	NA	14.909
1996	0.362	0.372	0.162	3.221	0.048	NA	NA	11.035
1997	0.593	0.140	0.825	2.553	0.000	0.000	NA	35.887
1998	0.669	0.028	0.023	2.823	0.269	0.000	NA	22.977
1999	0.211	0.052	2.057	3.895	0.000	0.000	NA	25.515
2000	0.460	0.020	0.357	3.897	0.197	NA	NA	25.818
2001	0.440	0.059	0.000	4.766	0.087	0.000	NA	27.423
2002	0.593	0.276	0.078	2.780	0.972	0.000	NA	38.587
2003	0.551	0.020	0.100	3.846	0.558	0.000	NA	36.264
2004	0.263	0.065	0.000	4.100	0.085	0.000	1.313	36.659
2005	0.513	0.020	0.182	4.115	0.091	0.000	2.097	55.343
2006	0.610	0.277	0.000	5.444	0.181	NA	2.849	41.059
2007	0.283	0.060	0.024	4.678	0.647	0.000	2.303	49.569
2008	1.014	0.288	NA	5.360	0.030	0.000	3.618	64.346
2009	1.164	0.283	0.000	4.573	0.091	0.000	2.776	51.369
2010	0.178	0.393	0.063	8.241	0.214	0.000	1.678	44.525
2011	0.110	0.138	0.040	9.702	0.085	0.000	2.162	49.518
2012	1.411	0.290	0.030	6.214	1.713	0.000	3.044	88.805
2013	0.545	0.841	0.035	8.834	0.557	0.000	4.257	134.990
2014	0.681	0.811	0.320	14.455	0.257	0.000	6.375	156.574
2015	0.976	1.863	0.368	12.401	0.481	0.066	4.774	123.857
2016	0.706	2.103	0.261	11.592	1.306	0.000	5.662	143.286
2017	1.369	0.351	NA	15.528	0.287	0.000	8.246	89.121
2018	0.617	1.425	NA	23.898	2.798	0.033	8.485	142.200
2019	1.265	0.748	NA	25.270	0.330	0.000	8.831	353.680
2020	1.082	0.523	NA	18.368	0.577	0.200	9.323	371.786

^CGFS-Q4 data for 2020 here shown but not used for assessment purposes due to reduced survey area.

Table 15.6.5. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Time-series of abundance estimates for *Raja montagui* (all individuals). Information obtained from IBTS-Q1, IBTS-Q3 (roundfish areas 1–7), several BTS surveys and eastern Channel CGFS-Q4 in the period 1987–2020. Data extracted from DATRAS, except for BTS-BEL-Q3 (extracted from the National database). Estimates are in n.h^{-1} for all surveys except CGFS-Q4 where n.km^{-2} are used. Time-series updated in 2021 except for CGFS-Q4 (last update for this species provided in 2019 WGEF).

Year	IBTS-Q1	IBTS-Q3	BTS-ISI-Q3	BTS-ENG-Q3	BTS-TRI-Q3	BTS-BEL-Q3	CGFS-Q4
1987	0.053	NA	NA	NA	NA	NA	NA
1988	0.065	NA	0.000	NA	NA	NA	15.349
1989	0.180	NA	0.592	NA	NA	NA	6.469
1990	0.117	NA	0.278	NA	NA	NA	10.278
1991	1.210	0.172	0.579	NA	NA	NA	2.725
1992	0.188	0.200	0.184	NA	NA	NA	0.451
1993	0.223	0.221	0.637	0.349	NA	NA	3.594
1994	0.151	0.346	0.000	0.606	NA	NA	5.921
1995	0.387	0.082	0.000	0.526	NA	NA	3.099
1996	0.138	0.150	0.824	0.390	0.667		3.343
1997	0.543	0.007	0.226	0.585	0.000		4.29
1998	0.165	0.102	0.000	0.538	1.123		3.019
1999	0.146	0.377	0.000	0.684	1.079		0.567
2000	0.159	0.027	0.029	0.359	0.648		1.274
2001	0.127	0.054	0.000	0.338	1.015		1.285
2002	0.355	0.074	0.000	0.605	0.361		0.637
2003	0.395	0.061	0.033	0.105	0.247		2.596
2004	0.276	0.094	0.000	0.288	0.359	0.689	0.261
2005	0.539	0.376	0.000	0.066	0.136	1.394	3.425
2006	0.122	0.361	0.000	0.253	0.536	1.384	1.385
2007	0.694	0.859	0.000	0.123	0.239	1.022	1.441
2008	1.125	0.394	NA	0.333	0.167	0.522	0.229
2009	1.151	1.100	0.000	0.195	0.242	1.696	0
2010	0.895	1.184	0.000	0.425	0.273	1.117	0.29
2011	0.759	1.401	0.000	0.312	0.928	1.056	4.398
2012	0.678	1.419	0.000	0.188	1.305	1.166	2.169
2013	1.322	0.828	0.046	0.263	0.841	0.993	2.047
2014	0.979	1.254	0.160	0.212	0.543	1.923	4.248
2015	1.242	0.521	0.058	0.313	0.550	2.580	2.514
2016	1.060	0.915	0.135	1.026	2.445	2.609	0.671
2017	0.905	0.615	NA	0.390	0.911	4.132	1.28
2018	1.052	1.026	NA	0.395	1.366	5.320	0.729
2019	1.246	1.477	NA	0.885	0.871	3.281	NA
2020	1.028	0.352	NA	0.733	1.191	2.807	NA

Table 15.6.6. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Time-series of abundance estimates (n.h^{-1}) for *Raja brachyura* in 4.a (all individuals). Information obtained from IBTS-Q1, IBTS-Q3 (roundfish areas 1–7) in the period 1987–2020. Data extracted from DATRAS. Time-series updated in 2021.

Year	IBTS-Q1	IBTS-Q3
1987	0.000	NA
1988	0.000	NA
1989	0.047	NA
1990	0.000	NA
1991	0.000	0.000
1992	0.119	0.000
1993	0.035	0.000
1994	0.000	0.000
1995	0.000	0.000
1996	0.022	0.000
1997	0.000	0.000
1998	0.007	0.000
1999	0.021	0.000
2000	0.000	0.000
2001	0.000	0.000
2002	0.000	0.000
2003	0.064	0.000
2004	0.000	0.000
2005	0.000	0.000
2006	0.064	0.000
2007	0.429	0.077
2008	0.292	0.039
2009	0.286	0.200
2010	0.471	0.000
2011	0.137	0.340
2012	0.000	0.000
2013	0.654	0.000
2014	0.490	0.000
2015	0.039	0.000
2016	0.019	0.071
2017	0.000	0.036
2018	0.000	0.000
2019	0.061	0.000
2020	0.727	0.036

Table 15.6.7. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Time-series of abundance estimates for *Raja brachyura* in 4.c and 7.d (all individuals). Information obtained from IBTS-Q1, IBTS-Q3 (roundfish areas 1–7) and several BTS surveys and eastern Channel CGFS-Q4 in the period 1987–2020. Data extracted from DATRAS, except for BTS-BEL-Q3 (extracted from the National database). Estimates are in n.h^{-1} for all surveys except CGFS-Q4 where n.km^{-2} are used. Time-series updated in 2021.

Year	IBTS-Q1	IBTS-Q3	BTS-ISI-Q3	BTS-ENG-Q3	BTS-TRI-Q3	BTS-BEL-Q3	CGFS-Q4
1987	0.000	NA	NA	NA	NA	NA	NA
1988	0.000	NA	0.000	NA	NA	NA	0.000
1989	0.000	NA	0.000	NA	NA	NA	0.004
1990	0.000	NA	0.000	NA	NA	NA	0.000
1991	0.000	0.000	0.000	NA	NA	NA	0.000
1992	0.308	0.000	0.000	NA	NA	NA	0.000
1993	0.160	0.000	0.000	0.159	NA	NA	0.000
1994	0.000	0.000	0.000	0.121	NA	NA	0.001
1995	0.000	0.000	0.000	0.053	NA	NA	0.002
1996	0.000	0.000	0.000	0.052	0.000	NA	0.000
1997	0.000	0.000	0.000	0.027	0.000	NA	0.001
1998	0.000	0.000	0.000	0.077	0.000	NA	0.002
1999	0.039	0.000	0.000	0.158	0.000	NA	0.002
2000	0.000	0.000	0.056	0.103	0.000	NA	0.002
2001	0.000	0.000	0.000	0.154	0.000	NA	0.002
2002	0.000	0.000	0.000	0.105	0.000	NA	0.004
2003	0.019	0.000	0.000	0.132	0.000	NA	0.004
2004	0.000	0.000	0.000	0.137	0.242	0.121	0.004
2005	0.039	0.000	0.071	0.262	0.000	0.238	0.000
2006	0.115	0.000	0.000	0.054	0.323	0.279	0.002
2007	0.154	0.000	0.000	0.164	0.600	0.088	0.003
2008	0.423	0.000	NA	0.083	0.000	0.329	0.000
2009	0.051	0.000	0.000	0.153	0.000	0.589	0.004
2010	0.000	0.000	0.000	0.027	0.000	0.414	0.001
2011	0.037	0.000	0.000	0.140	0.000	0.117	0.005
2012	0.154	0.095	0.071	0.082	0.000	0.379	0.006
2013	0.111	0.000	0.000	0.187	0.000	0.614	0.003
2014	0.995	0.000	0.000	0.291	0.000	0.417	0.012
2015	0.346	0.000	0.000	0.132	1.239	0.762	0.004
2016	0.205	0.429	0.000	0.269	0.000	0.987	0.006
2017	0.481	0.333	NA	0.524	0.000	0.579	0.009
2018	0.747	0.571	NA	0.526	0.091	0.785	0.006
2019	0.852	0.238	NA	0.423	1.000	0.862	0.007
2020	0.160	0.500	NA	0.427	1.500	0.541	0.002

Table 15.6.8. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Time-series of biomass estimates (kg.h^{-1}) for *Amblyraja radiata* (all individuals). Information obtained from IBTS-Q1, IBTS-Q3 (roundfish areas 1–7) and several BTS surveys in the period 1987–2020. Data extracted from DATRAS.

Year	IBTS-Q1	IBTS-Q3	BTS-ISI-Q3	BTS-TRI-Q3	BTS-GFR-Q3
1987	3.746	NA	NA	NA	NA
1988	1.451	NA	0.178	NA	NA
1989	3.325	NA	0.075	NA	NA
1990	2.423	NA	0.387	NA	NA
1991	2.040	4.158	0.124	NA	NA
1992	3.485	1.340	0.038	NA	NA
1993	6.208	0.880	0.014	NA	0.391
1994	1.898	0.940	0.023	NA	3.200
1995	4.206	0.832	0.102	NA	0.295
1996	3.493	0.980	0.237	4.493	NA
1997	2.684	0.857	0.000	4.383	4.021
1998	2.861	1.207	0.000	6.313	0.154
1999	2.352	1.312	0.059	8.558	6.100
2000	3.282	1.386	0.000	8.015	NA
2001	1.236	2.124	0.016	4.733	4.890
2002	1.573	1.123	0.035	5.947	0.179
2003	1.469	1.270	0.034	4.551	0.164
2004	1.283	0.675	0.015	5.140	0.111
2005	1.158	0.772	0.171	5.407	0.036
2006	0.741	0.899	0.112	4.089	NA
2007	1.404	1.605	0.000	5.191	6.359
2008	1.192	1.232	NA	6.182	5.996
2009	0.533	1.542	0.494	6.321	4.587
2010	0.484	1.029	0.000	6.176	3.765
2011	0.501	1.239	0.000	4.709	2.789
2012	0.641	0.848	0.051	3.467	5.721
2013	0.265	0.561	0.047	3.253	2.753
2014	0.586	0.728	0.318	3.475	0.535
2015	0.716	1.148	0.074	4.071	3.039
2016	0.527	0.941	0.165	2.700	3.112
2017	0.597	0.606	NA	1.558	2.829
2018	0.167	0.614	NA	1.236	1.956
2019	0.238	0.463	NA	1.379	1.633
2020	0.120	0.441	NA	1.317	1.407

Table 15.6.9. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Time-series of biomass estimates ($kg.h^{-1}$) for *Leucoraja naevus* (all individuals). Information obtained from IBTS-Q1, IBTS-Q3 (roundfish areas 1–7) and several BTS surveys in the period 1987–2020. Data extracted from DATRAS. Time-series updated in 2021.

Year	IBTS-Q1	IBTS-Q3	BTS-ISI-Q3	BTS-TRI2-Q3
1987	0.109	NA	NA	NA
1988	0.518	NA	0.021	NA
1989	0.476	NA	0.000	NA
1990	0.558	NA	0.000	NA
1991	0.444	0.167	0.000	NA
1992	0.739	0.407	0.000	NA
1993	0.828	0.110	0.000	NA
1994	0.390	0.166	0.000	NA
1995	0.520	0.184	0.000	NA
1996	0.450	0.095	0.000	0.503
1997	0.198	0.308	0.000	0.726
1998	0.387	0.121	0.000	1.382
1999	0.342	0.322	0.000	0.944
2000	0.406	0.259	0.000	0.928
2001	0.215	0.282	0.000	0.379
2002	0.240	0.250	0.000	0.573
2003	0.170	0.214	0.000	1.080
2004	0.145	0.196	0.000	0.453
2005	0.181	0.296	0.000	0.544
2006	0.250	0.330	0.000	0.460
2007	0.286	0.225	0.000	0.854
2008	0.246	0.512	NA	1.473
2009	0.192	0.475	0.000	0.795
2010	0.296	0.630	0.000	0.258
2011	0.343	0.606	0.000	0.489
2012	0.375	0.705	0.000	0.514
2013	0.558	0.459	0.000	0.449
2014	0.376	0.315	0.000	0.564
2015	0.836	0.470	0.000	0.279
2016	0.430	0.432	0.000	0.577
2017	0.702	0.562	NA	0.798
2018	0.327	0.495	NA	0.689
2019	0.376	0.348	NA	0.424
2020	0.288	0.250	NA	0.467

Table 15.6.10. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Time-series of biomass estimates (kg.h^{-1}) for 'common skate complex' (all individuals). Information obtained from IBTS-Q1, IBTS-Q3 (roundfish areas 1–7) and BTS-TRI-Q3 in the period 1987–2020. Data extracted from DATRAS. Time-series updated in 2021.

Year	IBTS-Q1	IBTS-Q3	BTS-TRI-Q3
1987	0.000	NA	NA
1988	0.029	NA	NA
1989	0.000	NA	NA
1990	0.000	NA	NA
1991	0.113	0.010	NA
1992	0.000	0.000	NA
1993	0.042	0.000	NA
1994	0.000	0.000	NA
1995	0.000	0.000	NA
1996	0.030	0.000	0.000
1997	0.000	0.000	0.000
1998	0.015	0.028	0.000
1999	0.021	0.010	0.000
2000	0.000	0.000	0.000
2001	0.000	0.000	0.000
2002	0.015	0.025	0.000
2003	0.000	0.000	0.000
2004	0.000	0.000	0.000
2005	0.014	0.041	0.046
2006	0.000	0.009	0.000
2007	0.061	0.000	0.000
2008	0.004	0.059	0.000
2009	0.003	0.002	0.000
2010	0.026	0.000	0.000
2011	0.224	0.020	0.000
2012	0.000	0.249	0.130
2013	0.259	0.061	0.000
2014	0.175	0.119	0.025
2015	0.111	0.011	0.215
2016	0.254	0.157	0.000
2017	0.415	0.278	3.140
2018	0.643	0.048	0.000
2019	0.678	0.885	0.000
2020	1.118	0.670	0.038

Table 15.6.11. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Time-series of biomass estimates for *Raja clavata* (all individuals). Information obtained from IBTS-Q1, IBTS-Q3 (roundfish areas 1–7), several BTS surveys, and eastern Channel CGFS-Q4 in the period 1987–2020. Data extracted from DATRAS, except for BTS-BEL-Q3 (extracted from the National database). Estimates are in $kg.h^{-1}$ for all surveys except CGFS-Q4 where $kg.km^{-2}$ are used. Time-series updated in 2021.

Year	IBTS-Q1	IBTS-Q3	BTS-ISI-Q3	BTS-ENG-Q3	BTS-TRI-Q3	BTS-GFR-Q3	BTS-BEL-Q3	CGFS-Q4
1987	1.569	NA	NA	NA	NA	NA	NA	NA
1988	0.223	NA	0.004	NA	NA	NA	NA	NA
1989	0.916	NA	0.418	NA	NA	NA	NA	NA
1990	0.698	NA	0.806	NA	NA	NA	NA	NA
1991	8.856	0.534	0.000	NA	NA	NA	NA	NA
1992	0.959	0.408	0.698	NA	NA	NA	NA	NA
1993	0.310	0.366	0.000	1.088	NA	0.000	NA	19.857
1994	0.218	0.036	0.008	0.974	NA	0.000	NA	45.129
1995	0.081	0.052	0.011	0.782	NA	0.000	NA	32.690
1996	0.243	0.703	0.233	1.326	0.111	NA	NA	7.437
1997	0.512	0.212	0.588	1.162	0.000	0.000	NA	50.848
1998	0.154	0.009	0.004	1.162	0.130	0.000	NA	45.941
1999	0.121	0.131	1.130	1.773	0.000	0.000	NA	36.231
2000	0.261	0.038	0.298	1.577	0.074	NA	NA	47.508
2001	0.279	0.062	0.000	1.540	0.053	0.000	NA	38.327
2002	0.356	0.260	0.088	1.061	0.831	0.000	NA	56.775
2003	0.360	0.034	0.055	1.779	0.408	0.000	NA	41.689
2004	0.177	0.044	0.000	2.475	0.058	0.000	0.769	38.572
2005	0.393	0.027	0.471	1.557	0.094	0.000	0.395	87.306
2006	0.809	0.274	0.000	1.684	0.150	NA	0.682	70.294
2007	0.192	0.019	0.022	2.173	0.541	0.000	0.350	92.942
2008	1.594	0.340	NA	2.924	0.014	0.000	1.951	94.537
2009	1.034	0.243	0.000	2.172	0.142	0.000	1.915	89.228
2010	0.193	0.210	0.004	3.388	0.196	0.000	1.409	90.478
2011	0.049	0.204	0.096	2.475	0.056	0.000	1.353	66.975
2012	1.654	0.168	0.084	3.199	0.741	0.000	2.011	113.665
2013	0.529	1.048	0.012	2.360	0.305	0.000	2.366	223.638
2014	0.795	1.132	0.263	4.865	0.296	0.000	4.959	265.211
2015	1.031	1.561	0.490	4.670	0.651	0.141	2.766	211.768
2016	0.707	1.644	0.499	4.011	0.525	0.000	3.846	291.861
2017	1.637	0.629	NA	4.398	0.758	0.000	4.649	174.664
2018	0.656	1.621	NA	5.120	1.251	0.027	4.766	302.729
2019	1.415	0.631	NA	6.352	0.202	0.000	4.627	376.898
2020	1.318	0.601	NA	5.546	0.413	0.251	5.162	659.203^

^CGFS-Q4 data for 2020 here shown but not used for assessment purposes due to reduced survey area.

Table 15.6.12. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Time-series of biomass estimates for *Raja montagui* (all individuals). Information from IBTS-Q1, IBTS-Q3 (roundfish areas 1–7), several BTS surveys and eastern Channel CGFS-Q4 in the period 1987–2020. Data extracted from DATRAS, except for BTS-BEL-Q3 (extracted from the National database). Estimates are in kg.h^{-1} for all surveys except CGFS-Q4 where kg.km^{-2} are used. Time-series updated in 2021 except for CGFS-Q4 (last update for this species provided in 2019 WGEF).

Year	IBTS-Q1	IBTS-Q3	BTS-ISI-Q3	BTS-ENG-Q3	BTS-TRI-Q3	BTS-BEL-Q3	CGFS-Q4
1987	0.066	NA	NA	NA	NA	NA	NA
1988	0.068	NA	0.000	NA	NA	NA	22.215
1989	0.136	NA	0.163	NA	NA	NA	6.007
1990	0.116	NA	0.055	NA	NA	NA	9.587
1991	0.448	0.130	1.125	NA	NA	NA	3.364
1992	0.211	0.183	0.153	NA	NA	NA	0.721
1993	0.215	0.240	0.422	0.065	NA	NA	4.426
1994	0.179	0.439	0.000	0.212	NA	NA	9.903
1995	0.567	0.091	0.000	0.197	NA	NA	3.027
1996	0.154	0.110	0.584	0.166	0.409	NA	0.653
1997	0.252	0.005	0.262	0.296	0.000	NA	4.61
1998	0.218	0.069	0.000	0.148	0.504	NA	2.767
1999	0.183	0.444	0.000	0.143	0.638	NA	0.266
2000	0.135	0.024	0.013	0.128	0.063	NA	1.586
2001	0.130	0.029	0.000	0.082	0.091	NA	1.376
2002	0.237	0.056	0.000	0.282	0.198	NA	0.447
2003	0.299	0.040	0.058	0.032	0.072	NA	1.863
2004	0.204	0.110	0.000	0.067	0.215	0.283	0.047
2005	0.378	0.384	0.000	0.079	0.108	0.067	2.535
2006	0.066	0.263	0.000	0.109	0.482	0.071	2.999
2007	0.666	0.828	0.000	0.008	0.216	0.087	1.27
2008	1.020	0.387	NA	0.121	0.118	0.180	0.055
2009	0.677	0.903	0.000	0.088	0.103	0.501	0
2010	0.803	1.009	0.000	0.056	0.154	0.287	0.058
2011	0.633	1.229	0.000	0.144	0.434	0.743	3.359
2012	0.552	1.451	0.000	0.135	0.873	0.370	1.621
2013	0.994	0.731	0.043	0.182	0.644	0.369	2.363
2014	1.017	1.402	0.128	0.091	0.542	0.651	1.74
2015	1.367	0.588	0.057	0.138	0.566	0.567	1.63
2016	1.002	1.004	0.097	0.197	0.798	0.832	0.329
2017	0.855	0.666	NA	0.136	0.501	1.013	5.443
2018	1.179	1.098	NA	0.208	0.391	1.438	0.877
2019	1.091	1.584	NA	0.204	0.555	0.978	NA
2020	1.120	0.343	NA	0.260	0.458	0.439	NA

Table 15.6.13. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Time-series of biomass estimates (kg.h^{-1}) for *Raja brachyura* 4.a (all individuals). Information obtained from the IBTS-Q1 and IBTS-Q3 (roundfish areas 1–7) surveys in the period 1987–2020. Data extracted from DATRAS. Time-series updated in 2021.

Year	IBTS-Q1	IBTS-Q3
1987	0.000	NA
1988	0.000	NA
1989	0.072	NA
1990	0.000	NA
1991	0.000	0.000
1992	0.062	0.000
1993	0.073	0.000
1994	0.000	0.000
1995	0.000	0.000
1996	0.005	0.000
1997	0.000	0.000
1998	0.016	0.000
1999	0.017	0.000
2000	0.000	0.000
2001	0.000	0.000
2002	0.000	0.000
2003	0.088	0.000
2004	0.000	0.000
2005	0.000	0.000
2006	0.057	0.000
2007	0.895	0.267
2008	1.076	0.142
2009	0.604	0.904
2010	1.849	0.000
2011	0.669	1.515
2012	0.000	0.000
2013	2.724	0.000
2014	1.913	0.000
2015	0.221	0.000
2016	0.092	0.410
2017	0.000	0.116
2018	0.000	0.000
2019	0.237	0.000
2020	3.200	0.054

Table 15.6.14. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Time-series of biomass estimates for *Raja brachyura* in 4.c and 7.d (all individuals). Information obtained from IBTS-Q1, IBTS-Q3 (roundfish areas 1–7), several BTS surveys and eastern Channel CGFS-Q4, in the period 1987–2020. Data extracted from DATRAS, except for BTS-BEL-Q3 (extracted from the National database). Estimates are in $kg.h^{-1}$ for all surveys except CGFS-Q4 where $kg.km^{-2}$ are used.

Year	IBTS-Q1	IBTS-Q3	BTS-ISI-Q3	BTS-ENG-Q3	BTS-TRI-Q3	BTS-BEL-Q3	CGFS-Q4
1987	0.000	NA	NA	NA	NA	NA	NA
1988	0.000	NA	0.000	NA	NA	NA	0.000
1989	0.000	NA	0.000	NA	NA	NA	0.003
1990	0.000	NA	0.000	NA	NA	NA	0.000
1991	0.000	0.000	0.000	NA	NA	NA	0.000
1992	0.179	0.000	0.000	NA	NA	NA	0.000
1993	0.456	0.000	0.000	0.182	NA	NA	0.000
1994	0.000	0.000	0.000	0.013	NA	NA	0.001
1995	0.000	0.000	0.000	0.008	NA	NA	0.003
1996	0.000	0.000	0.000	0.006	0.000	NA	0.000
1997	0.000	0.000	0.000	0.003	0.000	NA	0.002
1998	0.000	0.000	0.000	0.008	0.000	NA	0.004
1999	0.084	0.000	0.000	0.049	0.000	NA	0.002
2000	0.000	0.000	0.025	0.012	0.000	NA	0.001
2001	0.000	0.000	0.000	0.069	0.000	NA	0.003
2002	0.000	0.000	0.000	0.076	0.000	NA	0.004
2003	0.034	0.000	0.000	0.066	0.000	NA	0.006
2004	0.000	0.000	0.000	0.045	1.316	0.115	0.002
2005	0.102	0.000	0.062	0.118	0.000	0.104	0.000
2006	0.024	0.000	0.000	0.026	0.224	0.111	0.002
2007	0.356	0.000	0.000	0.288	1.868	0.027	0.008
2008	0.766	0.000	NA	0.009	0.000	0.166	0.000
2009	0.071	0.000	0.000	0.068	0.000	0.147	0.007
2010	0.000	0.000	0.000	0.020	0.000	0.125	0.003
2011	0.009	0.000	0.000	0.097	0.000	0.150	0.007
2012	0.739	0.245	0.062	0.021	0.000	0.095	0.020
2013	0.414	0.000	0.000	0.068	0.000	0.107	0.005
2014	1.368	0.000	0.000	0.103	0.000	0.108	0.022
2015	0.587	0.000	0.000	0.046	0.129	0.169	0.017
2016	0.316	0.294	0.000	0.124	0.000	0.159	0.021
2017	1.086	0.662	NA	0.166	0.000	0.113	0.022
2018	1.835	0.442	NA	0.305	0.439	0.303	0.015
2019	2.264	0.352	NA	0.216	0.817	0.232	0.022
2020	0.492	0.638	NA	0.088	1.246	0.467	0.003^

^CGFS-Q4 data for 2020 here shown but not used for assessment purposes due to reduced survey area.

Table 15.6.15. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Time-series of exploitable biomass index (kg.h^{-1} for individuals ≥50 cm L_T) for *Amblyraja radiata*. Information obtained from IBTS-Q1, IBTS-Q3 (roundfish areas 1–7) and several BTS surveys in the period 1987–2020. Data extracted from DATRAS. Time-series updated in 2021.

Year	IBTS-Q1	IBTS-Q3	BTS-ISI-Q3	BTS-TRI-Q3	BTS-GFR-Q3
1987	0.496	NA	NA	NA	NA
1988	0.333	NA	0.000	NA	NA
1989	0.377	NA	0.000	NA	NA
1990	0.370	NA	0.000	NA	NA
1991	0.288	0.361	0.000	NA	NA
1992	0.335	0.128	0.000	NA	NA
1993	0.431	0.112	0.000	NA	0.053
1994	0.231	0.162	0.000	NA	0.679
1995	0.578	0.058	0.000	NA	0.106
1996	0.228	0.096	0.205	0.318	NA
1997	0.293	0.049	0.000	0.313	0.657
1998	0.322	0.175	0.000	0.776	0.000
1999	0.253	0.115	0.000	0.682	1.180
2000	0.363	0.108	0.000	0.419	NA
2001	0.089	0.145	0.000	0.295	0.454
2002	0.141	0.038	0.035	0.213	0.037
2003	0.152	0.067	0.000	0.194	0.000
2004	0.081	0.018	0.000	0.276	0.000
2005	0.053	0.000	0.000	0.066	0.000
2006	0.025	0.011	0.045	0.000	NA
2007	0.069	0.052	0.000	0.000	0.000
2008	0.037	0.000	NA	0.032	0.113
2009	0.012	0.014	0.000	0.038	0.215
2010	0.021	0.096	0.000	0.166	0.256
2011	0.037	0.020	0.000	0.222	0.224
2012	0.052	0.008	0.000	0.170	0.109
2013	0.014	0.014	0.000	0.000	0.000
2014	0.086	0.039	0.000	0.070	0.081
2015	0.008	0.043	0.000	0.028	0.000
2016	0.042	0.000	0.000	0.029	0.053
2017	0.030	0.007	NA	0.057	0.053
2018	0.031	0.000	NA	0.000	0.063
2019	0.000	0.007	NA	0.000	0.056
2020	0.000	0.014	NA	0.000	0.000

Table 15.6.16. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Time-series of exploitable biomass index (kg.h^{-1} for individuals ≥50 cm L_T) for *Leucoraja naevus*. Information obtained from IBTS-Q1, IBTS-Q3 (roundfish areas 1–7) and several BTS surveys in the period 1987–2020. Data extracted from DATRAS. Time-series updated in 2021.

Year	IBTS-Q1	IBTS-Q3	BTS-ISI-Q3	BTS-TRI2-Q3
1987	0.094	NA	NA	NA
1988	0.458	NA	0.000	NA
1989	0.352	NA	0.000	NA
1990	0.485	NA	0.000	NA
1991	0.329	0.097	0.000	NA
1992	0.639	0.326	0.000	NA
1993	0.670	0.098	0.000	NA
1994	0.245	0.154	0.000	NA
1995	0.396	0.174	0.000	NA
1996	0.362	0.068	0.000	0.392
1997	0.145	0.293	0.000	0.417
1998	0.294	0.106	0.000	0.782
1999	0.269	0.245	0.000	0.400
2000	0.328	0.174	0.000	0.380
2001	0.137	0.118	0.000	0.048
2002	0.130	0.131	0.000	0.209
2003	0.102	0.115	0.000	0.234
2004	0.055	0.070	0.000	0.180
2005	0.091	0.156	0.000	0.185
2006	0.119	0.191	0.000	0.136
2007	0.160	0.122	0.000	0.434
2008	0.130	0.305	NA	0.112
2009	0.084	0.330	0.000	0.188
2010	0.182	0.435	0.000	0.050
2011	0.209	0.437	0.000	0.190
2012	0.276	0.520	0.000	0.255
2013	0.349	0.354	0.000	0.147
2014	0.218	0.167	0.000	0.218
2015	0.691	0.391	0.000	0.097
2016	0.328	0.328	0.000	0.186
2017	0.530	0.418	NA	0.191
2018	0.252	0.360	NA	0.232
2019	0.275	0.231	NA	0.084
2020	0.205	0.159	NA	0.059

Table 15.6.17. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Time-series of exploitable biomass index (kg.h^{-1} for individuals ≥50 cm L_T) for 'common skate complex'. Information obtained from IBTS-Q1, IBTS-Q3 (roundfish areas 1–7) and BTS survey in the period 1987–2020. Data extracted from DATRAS. Time-series updated in 2021.

Year	IBTS-Q1	IBTS-Q3	BTS-TRI-Q3
1987	0.000	NA	NA
1988	0.029	NA	NA
1989	0.000	NA	NA
1990	0.000	NA	NA
1991	0.113	0.010	NA
1992	0.000	0.000	NA
1993	0.042	0.000	NA
1994	0.000	0.000	NA
1995	0.000	0.000	NA
1996	0.025	0.000	0.000
1997	0.000	0.000	0.000
1998	0.016	0.028	0.000
1999	0.021	0.000	0.000
2000	0.000	0.000	0.000
2001	0.000	0.000	0.000
2002	0.015	0.025	0.000
2003	0.000	0.000	0.000
2004	0.000	0.000	0.000
2005	0.014	0.041	0.000
2006	0.000	0.009	0.000
2007	0.055	0.000	0.000
2008	0.000	0.059	0.000
2009	0.000	0.000	0.000
2010	0.011	0.000	0.000
2011	0.215	0.010	0.000
2012	0.000	0.229	0.130
2013	0.237	0.041	0.000
2014	0.170	0.109	0.000
2015	0.101	0.011	0.215
2016	0.249	0.151	0.000
2017	0.412	0.271	3.140
2018	0.636	0.040	0.000
2019	0.675	0.878	0.000
2020	1.098	0.665	0.038

Table 15.6.18. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Time-series of exploitable biomass index (individuals ≥50 cm L_T) for *Raja clavata*. Information obtained from IBTS-Q1, IBTS-Q3 (roundfish areas 1–7), several BTS surveys, and eastern Channel CGFS Q4 in the period 1987–2020. Data extracted from DATRAS, except for BTS-BEL-Q3 (extracted from National database). Estimates are in $kg.h^{-1}$ for all surveys except CGFS-Q4 where $kg.km^{-2}$ are used. Time-series updated in 2021.

Year	IBTS-Q1	IBTS-Q3	BTS-ISI-Q3	BTS-ENG-Q3	BTS-TRI-Q3	BTS-GFR-Q3	BTS-BEL-Q3	CGFS-Q4
1987	1.458	NA	NA	NA	NA	NA	NA	NA
1988	0.183	NA	0.000	NA	NA	NA	NA	NA
1989	0.734	NA	0.277	NA	NA	NA	NA	NA
1990	0.525	NA	0.601	NA	NA	NA	NA	NA
1991	3.043	0.394	0.000	NA	NA	NA	NA	NA
1992	0.634	0.202	0.610	NA	NA	NA	NA	NA
1993	0.240	0.221	0.000	0.589	NA	0.000	NA	19.857
1994	0.098	0.031	0.000	0.563	NA	0.000	NA	45.129
1995	0.069	0.053	0.000	0.562	NA	0.000	NA	32.690
1996	0.145	0.654	0.207	0.804	0.111	NA	NA	7.437
1997	0.368	0.209	0.439	0.702	0.000	0.000	NA	50.848
1998	0.018	0.000	0.000	0.565	0.045	0.000	NA	45.941
1999	0.050	0.130	0.657	1.117	0.000	0.000	NA	36.231
2000	0.131	0.033	0.186	0.908	0.031	NA	NA	47.508
2001	0.131	0.055	0.000	0.874	0.040	0.000	NA	38.327
2002	0.158	0.200	0.086	0.502	0.675	0.000	NA	56.775
2003	0.227	0.031	0.000	1.066	0.256	0.000	NA	41.689
2004	0.097	0.041	0.000	1.508	0.031	0.000	0.552	38.572
2005	0.272	0.026	0.471	0.601	0.072	0.000	0.125	87.306
2006	0.709	0.202	0.000	0.996	0.130	NA	0.034	70.294
2007	0.129	0.013	0.022	1.357	0.374	0.000	0.000	92.942
2008	1.480	0.279	NA	1.937	0.000	0.000	1.458	94.537
2009	0.779	0.173	0.000	1.409	0.138	0.000	1.348	89.228
2010	0.171	0.104	0.000	2.170	0.146	0.000	1.148	90.478
2011	0.034	0.176	0.096	1.267	0.028	0.000	0.976	66.975
2012	1.418	0.103	0.084	1.892	0.245	0.000	1.226	113.665
2013	0.436	0.906	0.000	1.023	0.213	0.000	1.446	223.638
2014	0.682	1.026	0.129	2.810	0.253	0.000	3.831	265.211
2015	0.853	1.009	0.454	2.719	0.627	0.141	1.663	211.768
2016	0.584	1.075	0.482	1.963	0.188	0.000	2.813	291.861
2017	1.410	0.608	NA	2.284	0.749	0.000	3.432	174.664
2018	0.565	1.402	NA	2.628	0.533	0.027	3.603	302.729
2019	1.168	0.467	NA	3.537	0.147	0.000	2.927	376.898
2020	1.142	0.490	NA	2.630	0.306	0.251	3.659	659.203^

^CGFS-Q4 data for 2020 here shown but not used for assessment purposes due to reduced survey area.

Table 15.6.19. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Time-series of exploitable biomass index (individuals ≥50 cm L_T) for *Raja montagui*. Information obtained from IBTS-Q1, IBTS-Q3 (roundfish areas 1–7), several BTS surveys, and eastern Channel CGFS Q4, in the period 1987–2020. Data extracted from DATRAS, except for BTS-BEL-Q3 (extracted from National database). Estimates are in $kg.h^{-1}$ for all surveys except CGFS-Q4 where $kg.km^{-2}$ are used. Time-series updated in 2021 except for CGFS-Q4 (last update for this species provided in 2019 WGEF).

Year	IBTS-Q1	IBTS-Q3	BTS-ISI-Q3	BTS-ENG-Q3	BTS-TRI-Q3	BTS-BEL-Q3	CGFS-Q4
1987	0.063	NA	NA	NA	NA	NA	NA
1988	0.060	NA	0.000	NA	NA	NA	0.514
1989	0.099	NA	0.049	NA	NA	NA	1.347
1990	0.102	NA	0.000	NA	NA	NA	2.123
1991	0.299	0.090	1.048	NA	NA	NA	0.84
1992	0.185	0.144	0.079	NA	NA	NA	0.205
1993	0.166	0.214	0.261	0.000	NA	NA	1.257
1994	0.163	0.405	0.000	0.106	NA	NA	2.438
1995	0.508	0.090	0.000	0.118	NA	NA	0.748
1996	0.141	0.090	0.284	0.095	0.243	NA	0
1997	0.168	0.000	0.218	0.205	0.000	NA	0.686
1998	0.206	0.014	0.000	0.035	0.383	NA	0.651
1999	0.169	0.406	0.000	0.000	0.548	NA	0
2000	0.100	0.010	0.000	0.065	0.000	NA	0.333
2001	0.110	0.007	0.000	0.044	0.000	NA	0.276
2002	0.152	0.029	0.000	0.187	0.103	NA	0.103
2003	0.221	0.026	0.058	0.000	0.000	NA	0.201
2004	0.168	0.101	0.000	0.028	0.094	0.210	0
2005	0.209	0.324	0.000	0.079	0.060	0.000	0.669
2006	0.038	0.193	0.000	0.097	0.379	0.000	0.699
2007	0.537	0.624	0.000	0.000	0.183	0.000	0.327
2008	0.808	0.320	NA	0.087	0.058	0.133	0
2009	0.334	0.623	0.000	0.000	0.041	0.257	0
2010	0.624	0.783	0.000	0.027	0.107	0.151	0
2011	0.457	0.889	0.000	0.110	0.196	0.523	0.796
2012	0.426	1.209	0.000	0.082	0.535	0.218	0.08
2013	0.782	0.528	0.031	0.168	0.427	0.192	0.716
2014	0.931	1.280	0.051	0.049	0.447	0.473	0.158
2015	1.260	0.571	0.040	0.104	0.526	0.217	0.279
2016	0.819	0.890	0.049	0.103	0.264	0.372	0
2017	0.760	0.578	NA	0.094	0.310	0.453	1.708
2018	1.056	0.982	NA	0.152	0.172	0.587	0.228
2019	0.871	1.369	NA	0.142	0.386	0.697	NA
2020	1.005	0.274	NA	0.176	0.168	0.097	NA

Table 15.6.20. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Time-series of exploitable biomass index (kg.h^{-1} for individuals ≥50 cm L_T) for *Raja brachyura* 4.a. Information obtained from IBTS-Q1, IBTS-Q3 (roundfish areas 1–7) surveys in the period 1987–2020. Data extracted from DATRAS. Time-series updated in 2021.

Year	IBTS-Q1	IBTS-Q3
1987	0.000	NA
1988	0.000	NA
1989	0.072	NA
1990	0.000	NA
1991	0.000	0.000
1992	0.000	0.000
1993	0.073	0.000
1994	0.000	0.000
1995	0.000	0.000
1996	0.000	0.000
1997	0.000	0.000
1998	0.016	0.000
1999	0.000	0.000
2000	0.000	0.000
2001	0.000	0.000
2002	0.000	0.000
2003	0.088	0.000
2004	0.000	0.000
2005	0.000	0.000
2006	0.020	0.000
2007	0.887	0.267
2008	1.076	0.142
2009	0.604	0.904
2010	1.849	0.000
2011	0.669	1.515
2012	0.000	0.000
2013	2.697	0.000
2014	1.913	0.000
2015	0.221	0.000
2016	0.092	0.410
2017	0.000	0.116
2018	0.000	0.000
2019	0.207	0.000
2020	3.184	0.054

Table 15.6.21. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Time-series of exploitable biomass index (individuals ≥50 cm L_T) for *Raja brachyura* 4.c and 7.d. Information obtained from IBTS-Q1, IBTS-Q3 (roundfish areas 1–7), several BTS surveys, and eastern Channel CGFS-Q4 in the period 1989–2020. Data extracted from DATRAS, except for BTS-BEL-Q3 (extracted from National database). Estimates are in $kg.h^{-1}$ for all surveys except CGFS-Q4 where $kg.km^{-2}$ are used. Time-series updated in 2021.

Year	IBTS-Q1	IBTS-Q3	BTS-ISI-Q3	BTS-ENG-Q3	BTS-TRI-Q3	BTS-BEL-Q3	CGFS-Q4
1987	0.000	NA	NA	NA	NA	NA	NA
1988	0.000	NA	0.000	NA	NA	NA	0.000
1989	0.000	NA	0.000	NA	NA	NA	0.001
1990	0.000	NA	0.000	NA	NA	NA	0.000
1991	0.000	0.000	0.000	NA	NA	NA	0.000
1992	0.055	0.000	0.000	NA	NA	NA	0.000
1993	0.449	0.000	0.000	0.161	NA	NA	0.000
1994	0.000	0.000	0.000	0.000	NA	NA	0.000
1995	0.000	0.000	0.000	0.000	NA	NA	0.003
1996	0.000	0.000	0.000	0.000	0.000	NA	0.000
1997	0.000	0.000	0.000	0.000	0.000	NA	0.002
1998	0.000	0.000	0.000	0.000	0.000	NA	0.004
1999	0.084	0.000	0.000	0.000	0.000	NA	0.002
2000	0.000	0.000	0.000	0.000	0.000	NA	0.000
2001	0.000	0.000	0.000	0.032	0.000	NA	0.003
2002	0.000	0.000	0.000	0.028	0.000	NA	0.003
2003	0.034	0.000	0.000	0.044	0.000	NA	0.006
2004	0.000	0.000	0.000	0.000	1.316	0.095	0.001
2005	0.102	0.000	0.000	0.072	0.000	0.047	0.000
2006	0.000	0.000	0.000	0.025	0.198	0.000	0.002
2007	0.352	0.000	0.000	0.259	1.868	0.000	0.008
2008	0.739	0.000	NA	0.000	0.000	0.062	0.000
2009	0.062	0.000	0.000	0.029	0.000	0.080	0.006
2010	0.000	0.000	0.000	0.000	0.000	0.030	0.003
2011	0.000	0.000	0.000	0.087	0.000	0.147	0.006
2012	0.740	0.245	0.000	0.000	0.000	0.040	0.019
2013	0.413	0.000	0.000	0.026	0.000	0.026	0.005
2014	1.162	0.000	0.000	0.037	0.000	0.080	0.021
2015	0.563	0.000	0.000	0.000	0.000	0.059	0.017
2016	0.299	0.139	0.000	0.071	0.000	0.000	0.020
2017	0.963	0.590	NA	0.044	0.000	0.026	0.022
2018	1.709	0.385	NA	0.220	0.439	0.063	0.015
2019	2.150	0.343	NA	0.178	0.677	0.070	0.020
2020	0.471	0.482	NA	0.000	0.808	0.281	0.002^

^CGFS-Q4 data for 2020 here shown but not used for assessment purposes due to reduced survey area.

Table 15.7.1: Length-weight parameters (a and b) used to convert length to weight (values taken from Silva *et al*., 2013).

Species	a	b
Leucoraja. Naevus	0.0036	3.1399
Raja brachyura	0.0027	3.2580
Raja clavata	0.0045	3.0961
Raja microocellata	0.0030	3.2250
Raja montagui	0.0041	3.1152
Raja undulata	0.0040	3.1346
Amblyraja radiata	0.0107	2.940
'common skate complex'	0.0038	3.1201
Scyliorhinus canicula	0.0022	3.1194
Mustelus spp	0.003	3.0349

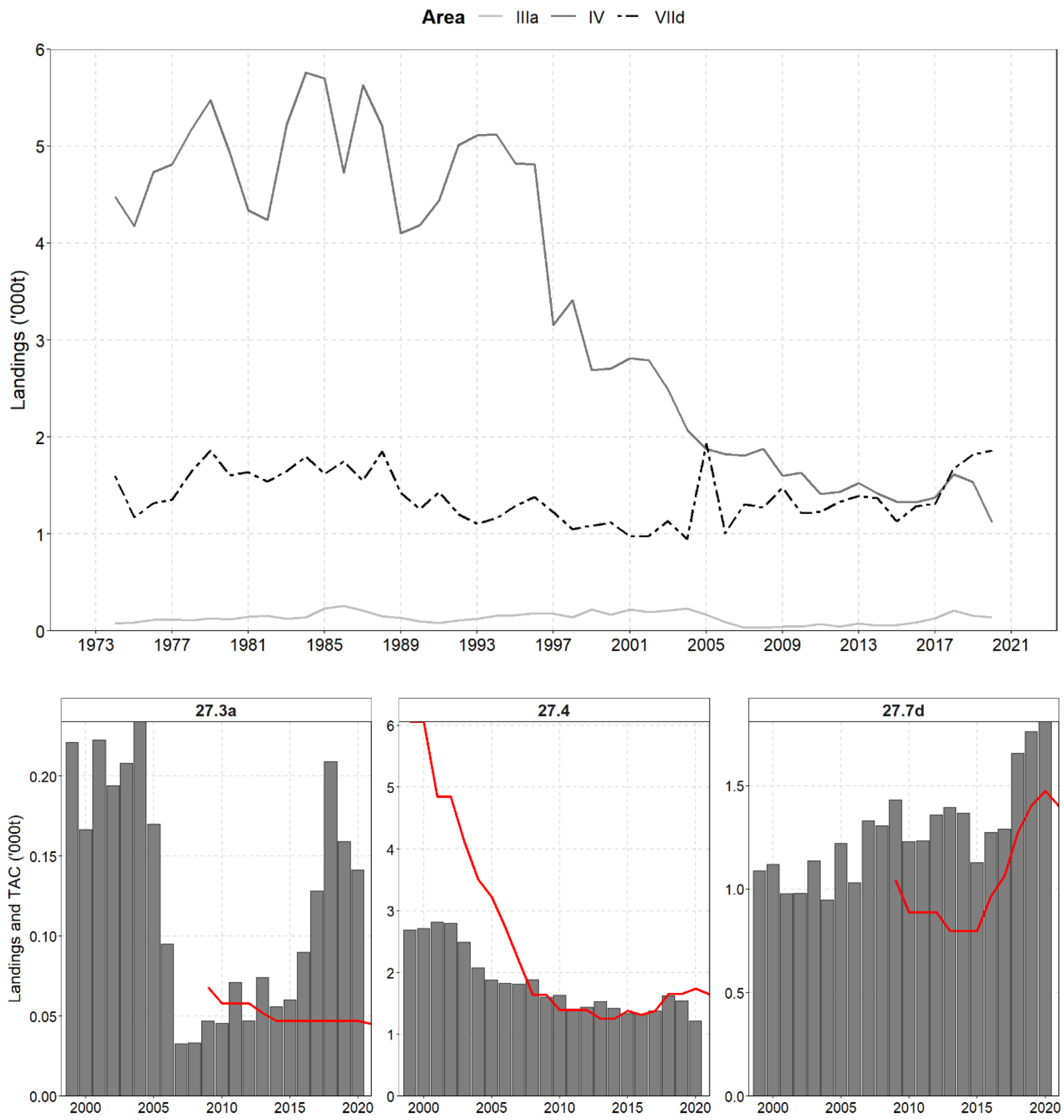

Figure 15.3.1. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. (top) total international landings of rays and skates in Division 3.a and Subarea 4 and Division 7.d since 1973, based on WG estimates. (bottom) Landings in Division 3.a, Subarea 4 and Division 7.d, including the TACs for the three areas (black lines) since 1999. Note: Different y-axis (bottom panel).

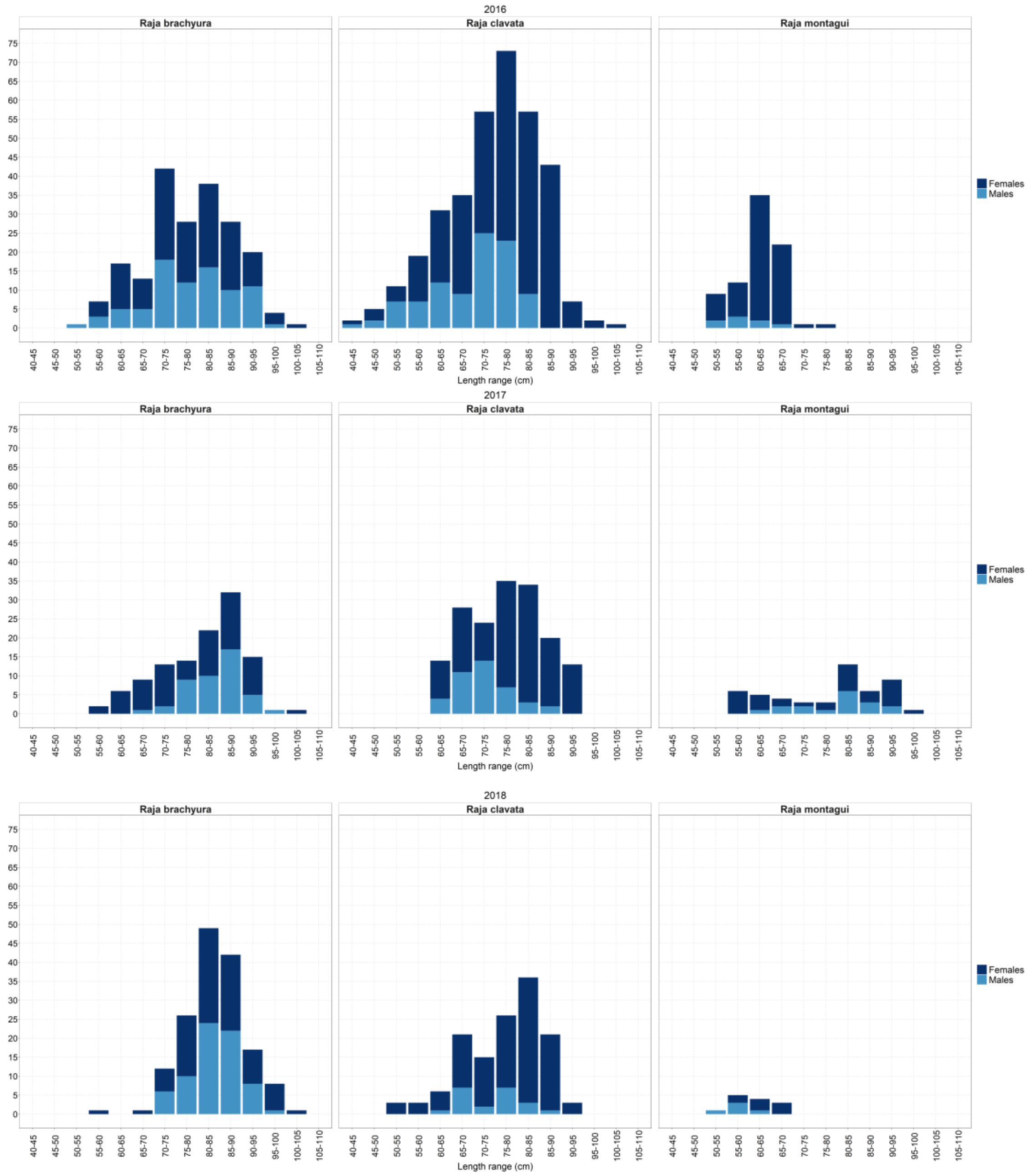

Figure 15.3.2. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Length–frequency distribution of *R. brachyura*, *R. clavata* and *R. montagui* measured during the market sampling programme of the Dutch beam trawl fleet in 2016–2020.

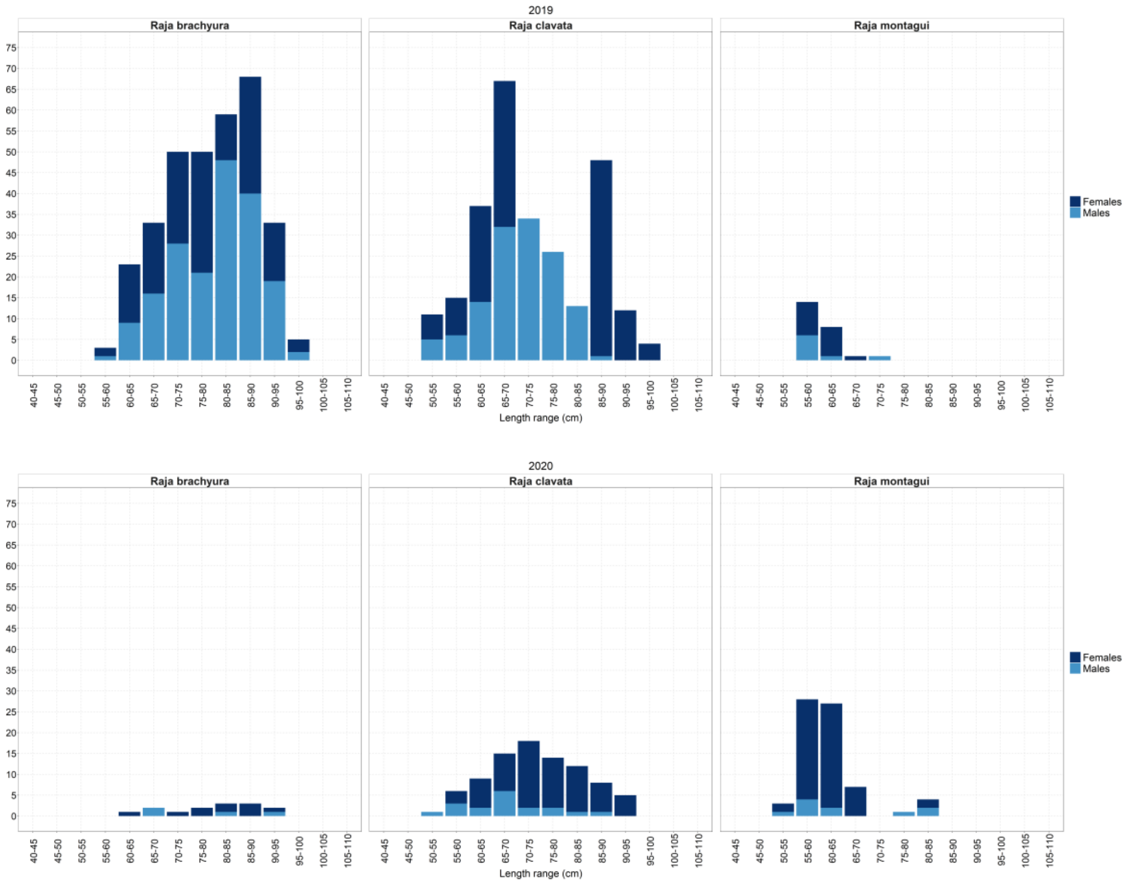

Figure 15.3.2 (continued). Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Length–frequency distribution of *R. brachyura*, *R. clavata* and *R. montagui* measured during the market sampling programme of the Dutch beam trawl fleet in 2016–2020.

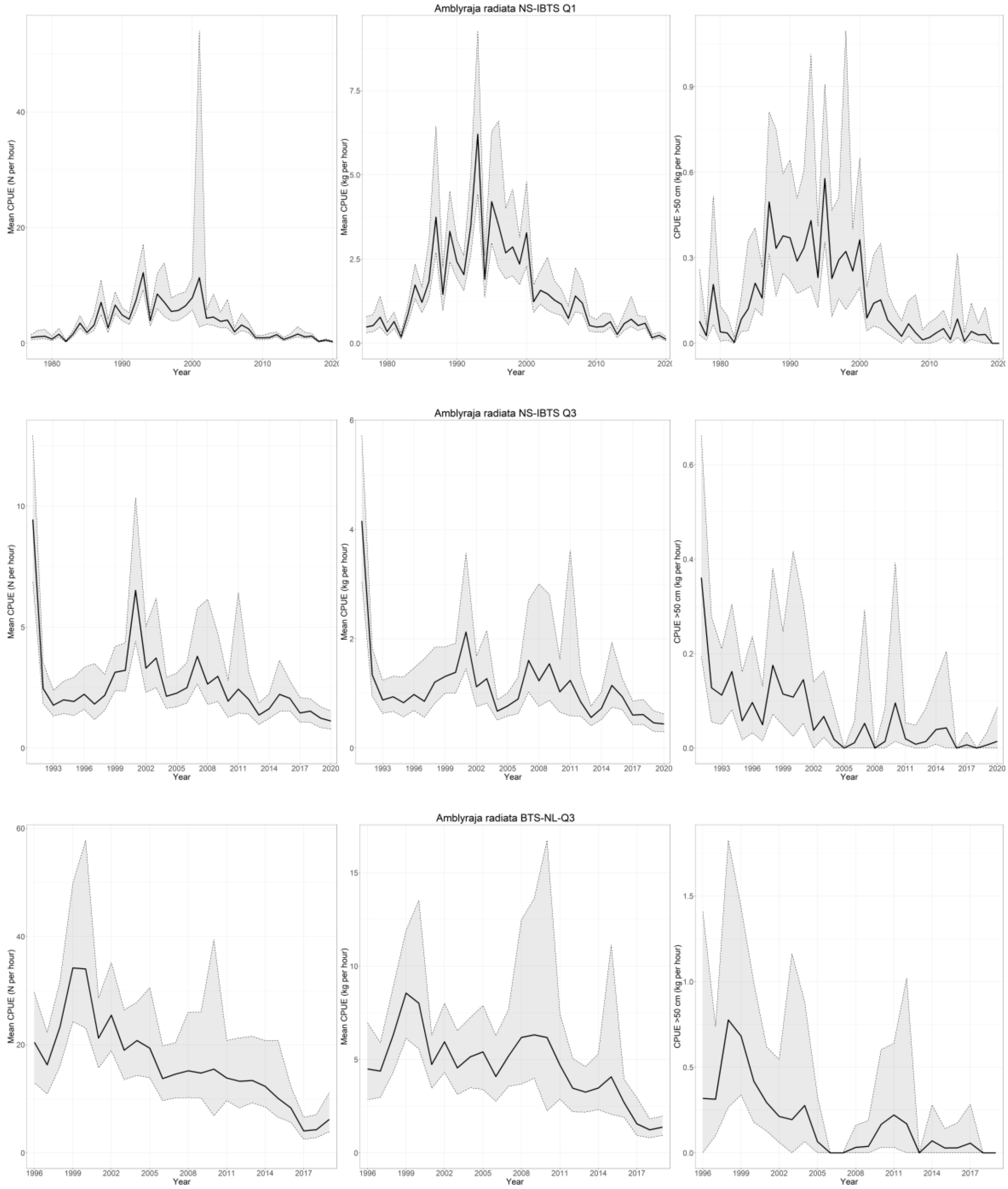

Figure 15.6.1. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. *Amblyraja radiata*. Abundance index (n. h^{-1}), biomass index (kg.h^{-1}) and exploitable biomass (kg.h^{-1}), with 95% confidence intervals, during the North Sea IBTS (in roundfish areas 1–7) and BTS in the years 1977–2020. Data extracted from the DATRAS database (selected for CPUE per length per haul) on 8 June 2021.

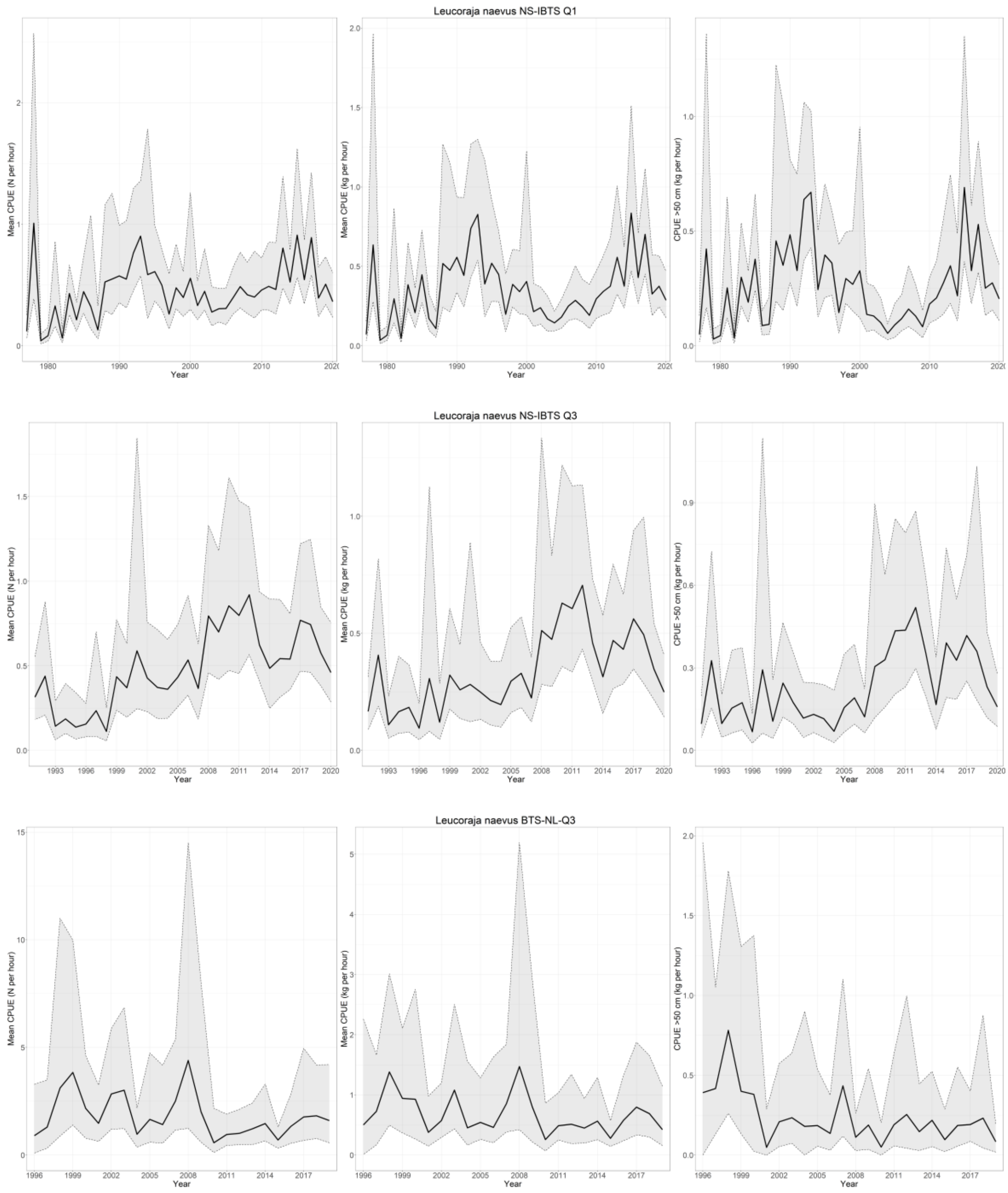

Figure 15.6.2. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. *Leucoraja naevus*. Abundance index ($n.h^{-1}$), biomass index ($kg.h^{-1}$) and exploitable biomass ($kg.h^{-1}$), with 95% confidence intervals, during the North Sea IBTS (in roundfish areas 1–7) and BTS surveys in the years 1977–2020. Data extracted from the DATRAS database (selected for CPUE per length per haul) on 8 June 2021.

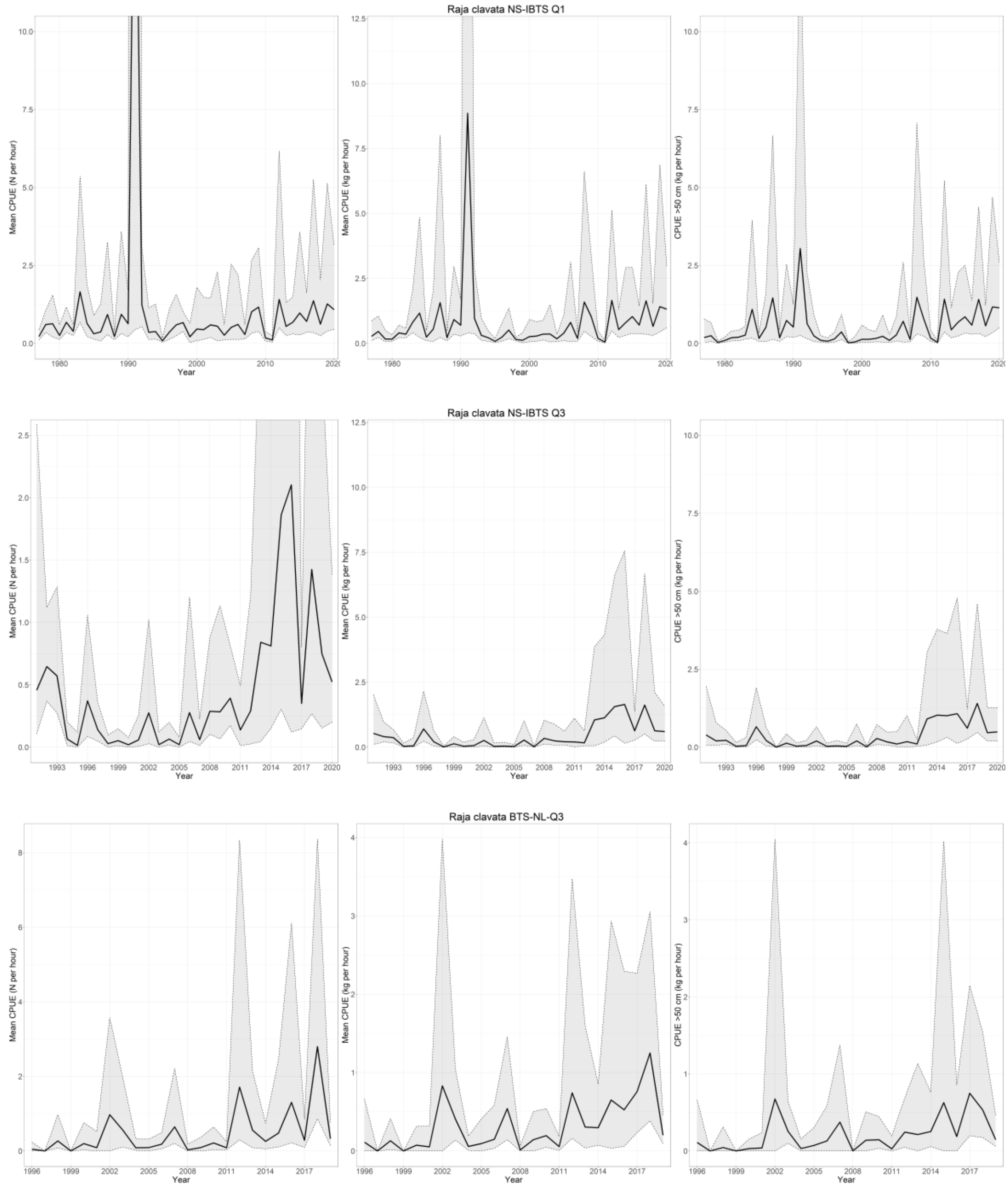

Figure 15.6.3. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. *Raja clavata*. Abundance index (n.h^{-1}), biomass index (kg.h^{-1}) and exploitable biomass (kg.h^{-1}), with 95% confidence intervals, during the North Sea IBTS (in roundfish areas 1–7), BTS, and CGFS-Q4 surveys in the years 1977–2020. Data for BTS-BEL-Q3 extracted from national database. Other data extracted from the DATRAS database, see Section 15.6.4 for details on data source.

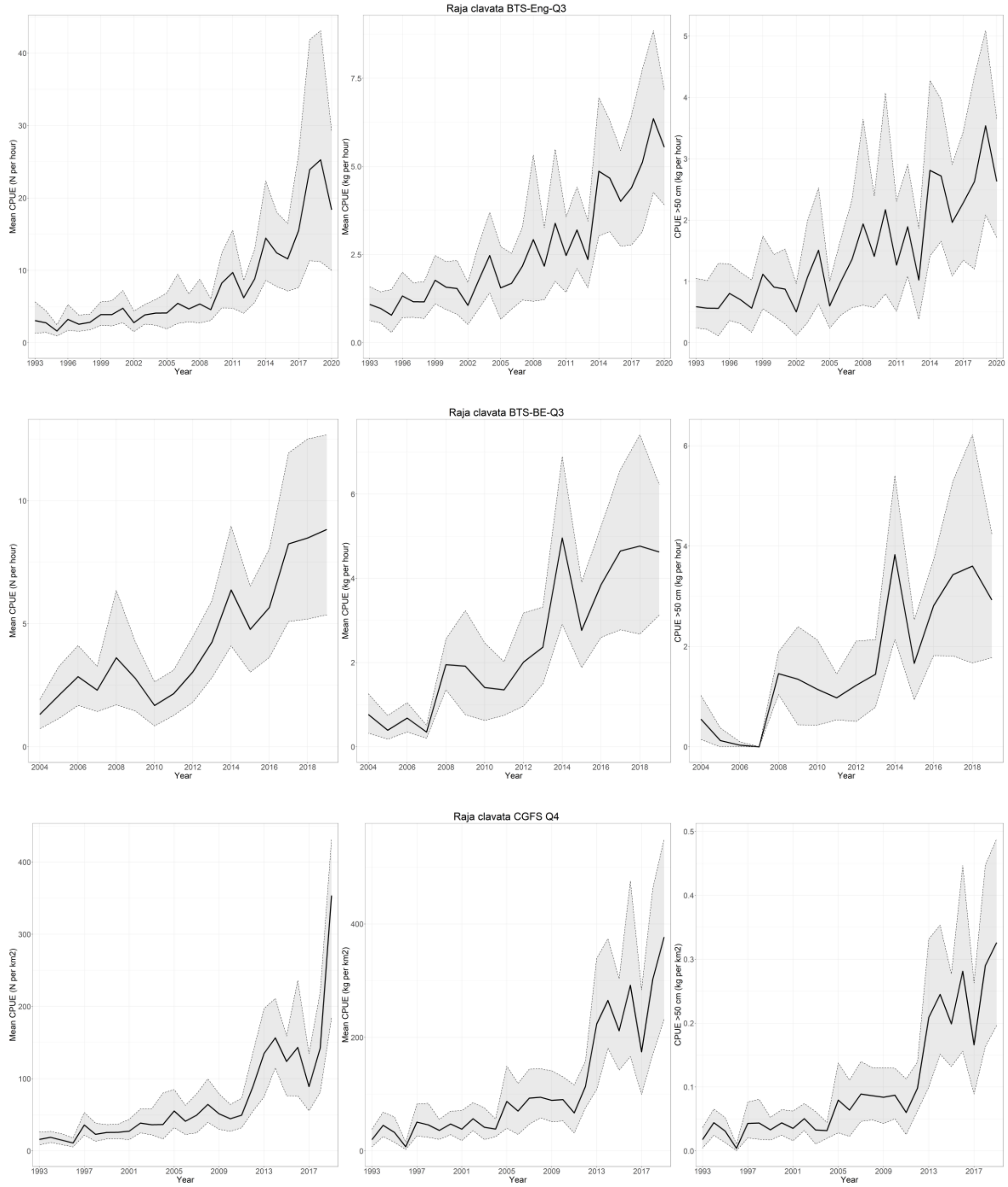

Figure 15.6.3 (continued). Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. *Raja clavata*. Abundance index ($n.h^{-1}$), biomass index ($kg.h^{-1}$) and exploitable biomass ($kg.h^{-1}$), with 95% confidence intervals, during the North Sea IBTS (in roundfish areas 1–7), BTS, and CGFS-Q4 surveys in the years 1977–2020. Data for BTS-BEL-Q3 extracted from national database. Other data extracted from the DATRAS database, see Section 15.6.4 for details on data source.

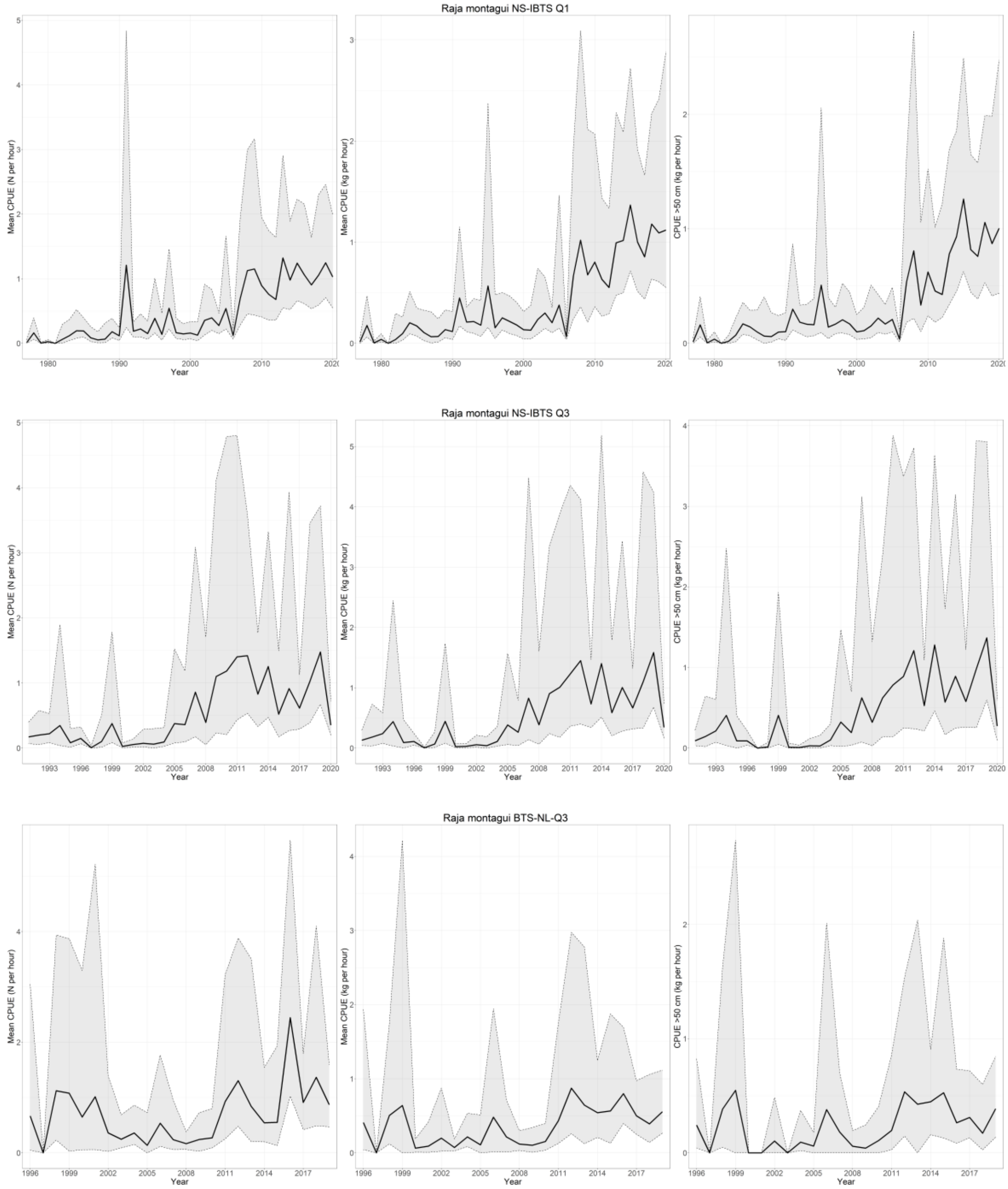

Figure 15.6.4. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. *Raja montagui*. Abundance index ($n.h^{-1}$), biomass index ($kg.h^{-1}$) and exploitable biomass ($kg.h^{-1}$), with 95% confidence intervals, during the North Sea IBTS (in roundfish areas 1–7) and BTS surveys in the years 1977–2020. Data for BTS-BEL-Q3 extracted from national database. Other data extracted from the DATRAS database, see Section 15.6.4 for details on data source.

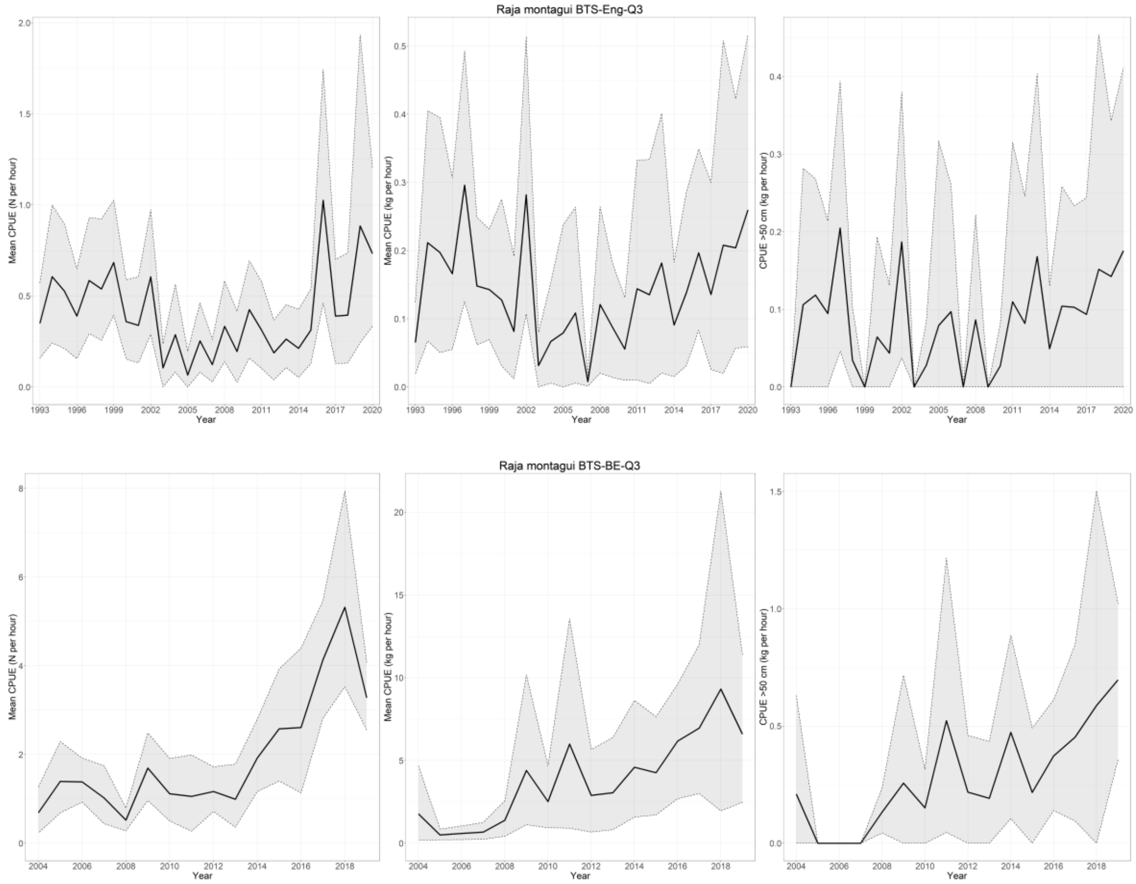

Figure 15.6.4 (continued). Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. *Raja montagui*. Abundance index (n.h^{-1}), biomass index (kg.h^{-1}) and exploitable biomass (kg.h^{-1}), with 95% confidence intervals, during the North Sea IBTS (in roundfish areas 1–7) and BTS surveys in the years 1977–2020. Data for BTS-BEL-Q3 extracted from national database. Other data extracted from the DATRAS database, see Section 15.6.4 for details on data source.

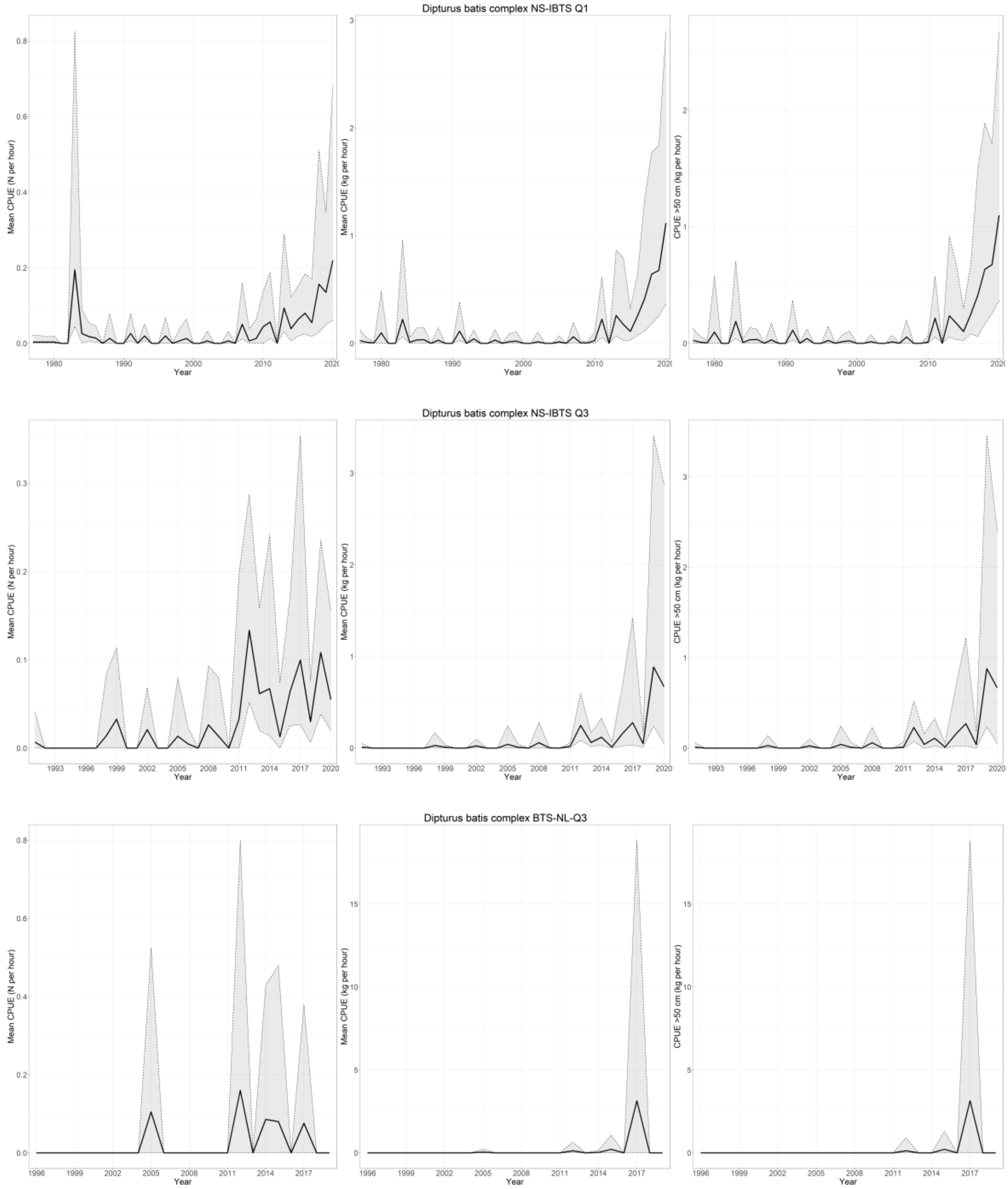

Figure 15.6.5. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. 'Common skate complex'. Abundance index ($n.h^{-1}$), biomass index ($kg.h^{-1}$) and exploitable biomass ($kg.h^{-1}$), with 95% confidence intervals, during the North Sea IBTS (in roundfish areas 1–7) and BTS surveys in the years 1977–2020. Data extracted from the DATRAS database (selected for CPUE per length per haul) on 8 June 2021.

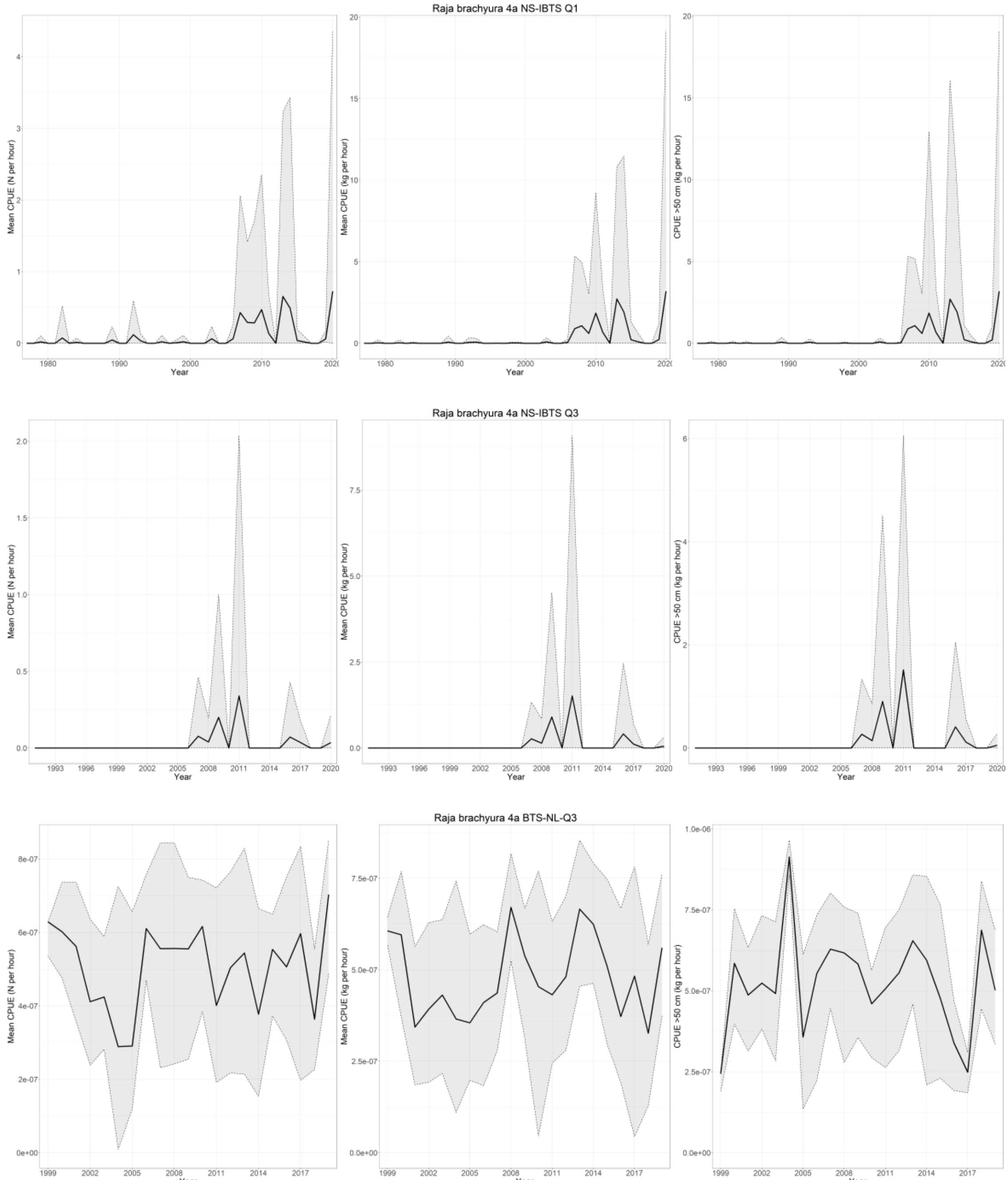

Figure 15.6.6. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. *Raja brachyura* in 4.a. Abundance index (n.h^{-1}), biomass index (kg.h^{-1}) and exploitable biomass (kg.h^{-1}), with 95% confidence intervals, during the North Sea IBTS (in roundfish areas 1–7) and BTS surveys in the years 1977–2020. Data extracted from the DATRAS database (selected for CPUE per length per haul) on 8 June 2021.

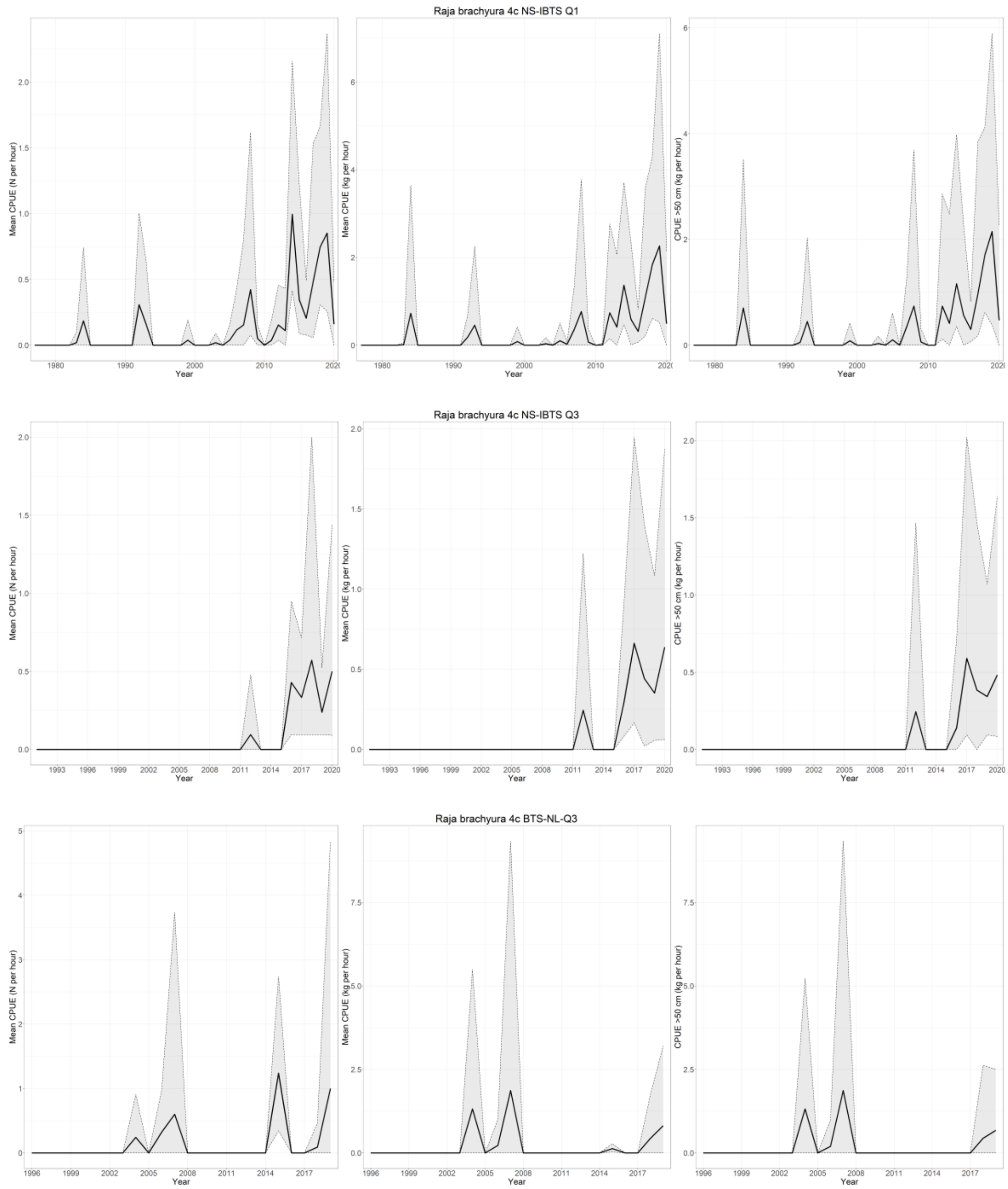

Figure 15.6.7. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. *Raja brachyura* 4.c. Abundance index (n.h^{-1}), biomass index (kg.h^{-1}) and exploitable biomass (kg.h^{-1}), with 95% confidence intervals, during the North Sea IBTS (in roundfish areas 1–7), BTS, and CGFS-Q4 surveys in the years 1977–2020. Data for BTS-BEL-Q3 extracted from national database. Other data extracted from the DATRAS database, see Section 15.6.4 for details on data source.

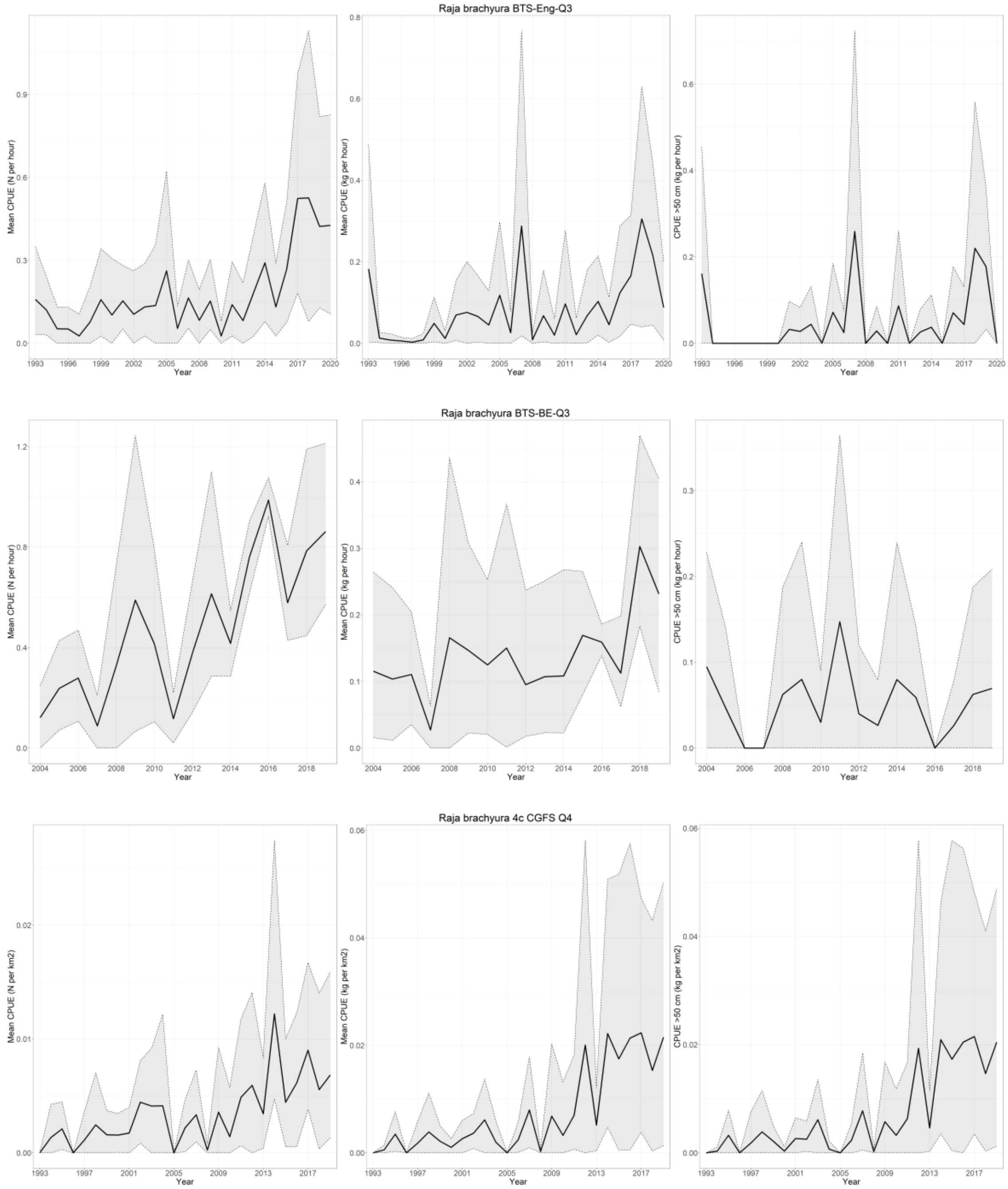

Figure 15.6.7 (continued). Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. *Raja brachyura* 4.c. Abundance index (n.h^{-1}), biomass index (kg.h^{-1}) and exploitable biomass (kg.h^{-1}), with 95% confidence intervals, during the North Sea IBTS (in roundfish areas 1–7), BTS, and CGFS-Q4 surveys in the years 1977–2020. Data for BTS-BEL-Q3 extracted from national database. Other data extracted from the DATRAS database, see Section 15.6.4 for details on data source.

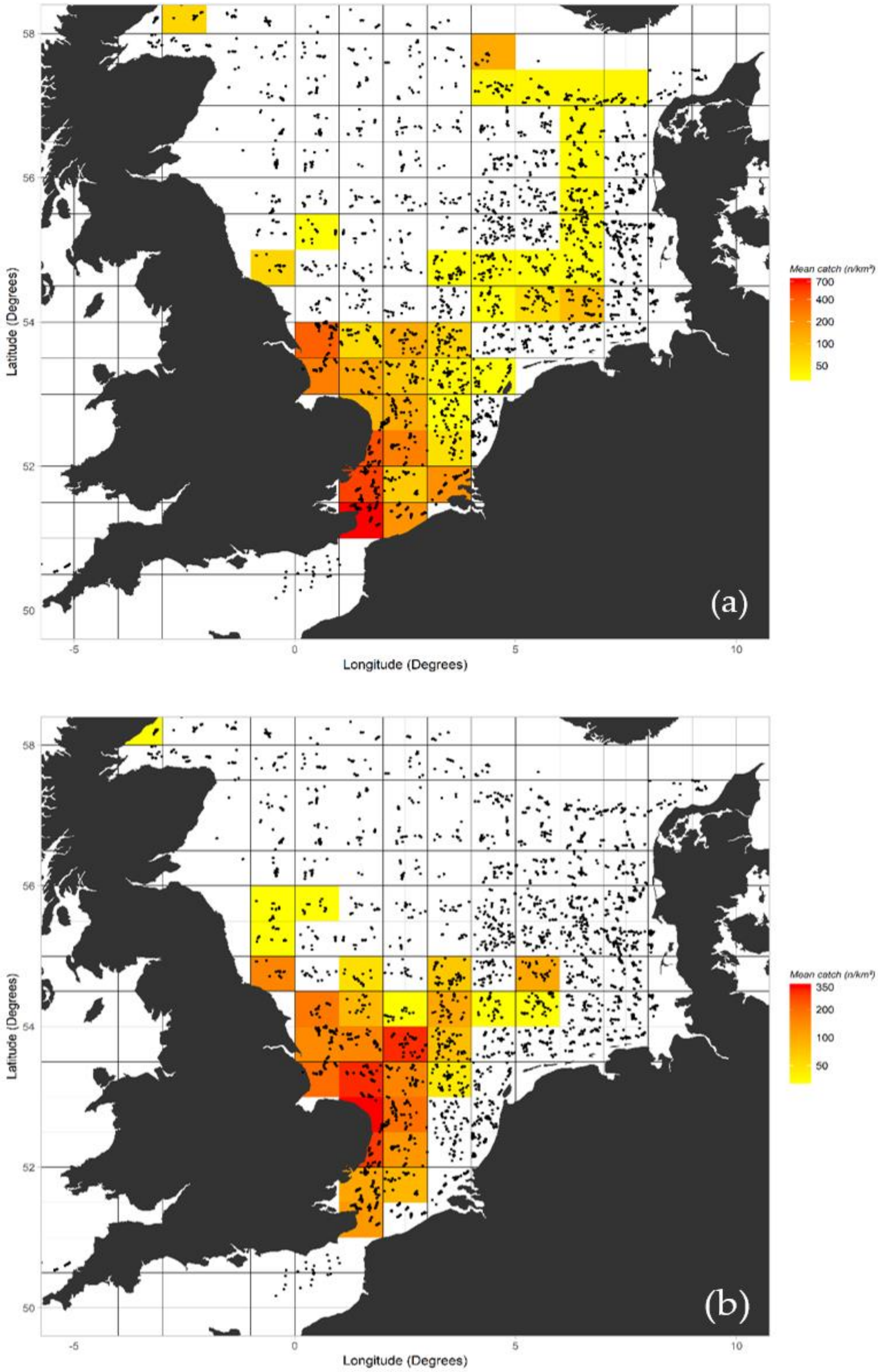

Figure 15.6.8. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Average (a) thornback ray and (b) spotted ray catches (n.km²) from all BTS surveys (German, Dutch and Belgian) in the central-southern North Sea (ICES Areas 27.4.b and 27.4.c) for the period 2004–2018. Black dots show the different shooting positions from the survey hauls over the entire period. Data extracted from DATRAS, except for the Belgian data between 2004 and 2009 which were provided from the national database at ILVO.

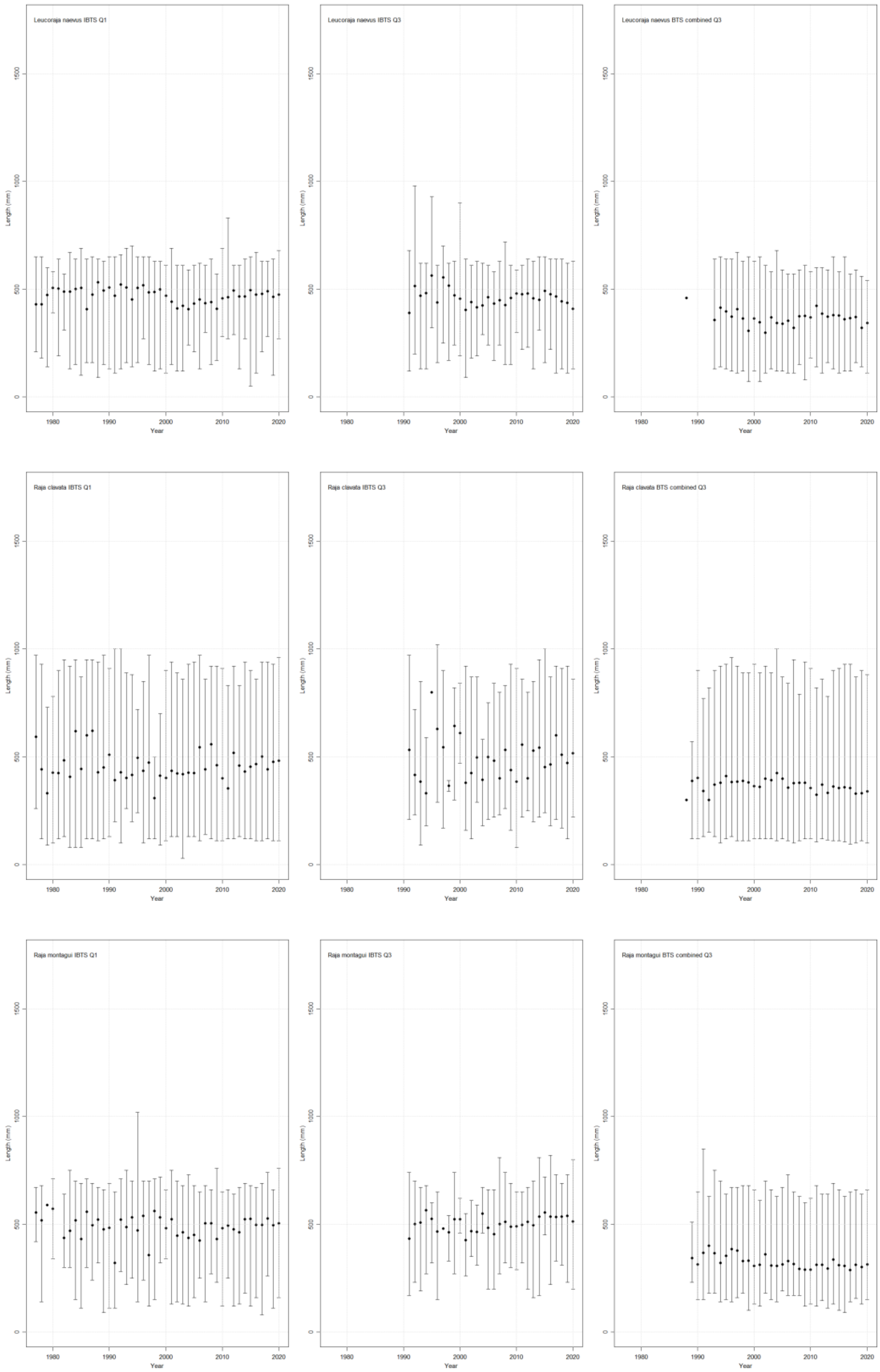

Figure 15.6.9. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Average length (dots) and length range during the North Sea IBTS (roundfish areas 1–7) and BTS surveys. Data extracted from the DATRAS database (selected for CPUE per length per hour) on 8 June 2021. NOTE: There are still some incorrect data in DATRAS, with some length records of all species (except *R. clavata*) that are above L_{max}.

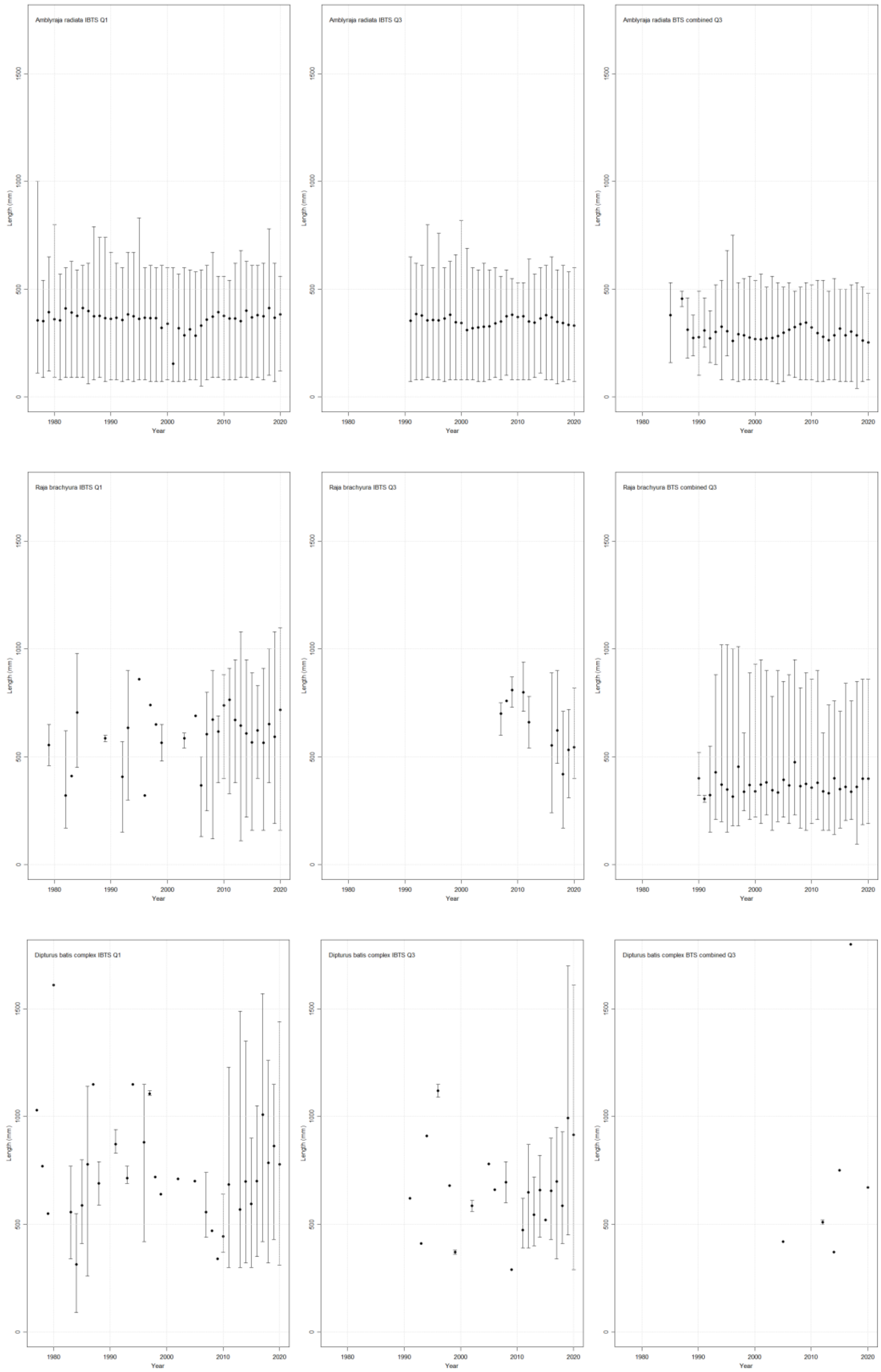

Figure 15.6.9 (continued). Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Average length (dots) and length range during the North Sea IBTS (roundfish areas 1–7) and BTS surveys. Data extracted from the DATRAS database (selected for CPUE per length per hour) on 8 June 2021. NOTE: There are still some incorrect data in DATRAS, with some length records of all species (except *R. clavata*) that are above L_{max}.

Figure 15.6.10. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Distribution plots of the main demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and Eastern Channel. Plots are based on IBTS-Q1, IBTS-Q3, and BTS data. Plots cover four periods: 1997–2002 (left panels), 2003–2008 (centre-left panels), 2009–2014 (centre right panels) and 2015–2020 (right panels). All data are extracted from DATRAS. Data for IBTS are extracted as CPUE per length per hour) on 8 June 2021. CGFS-Q4 data are not included in the plots. Bubble scale is equal in all panels.

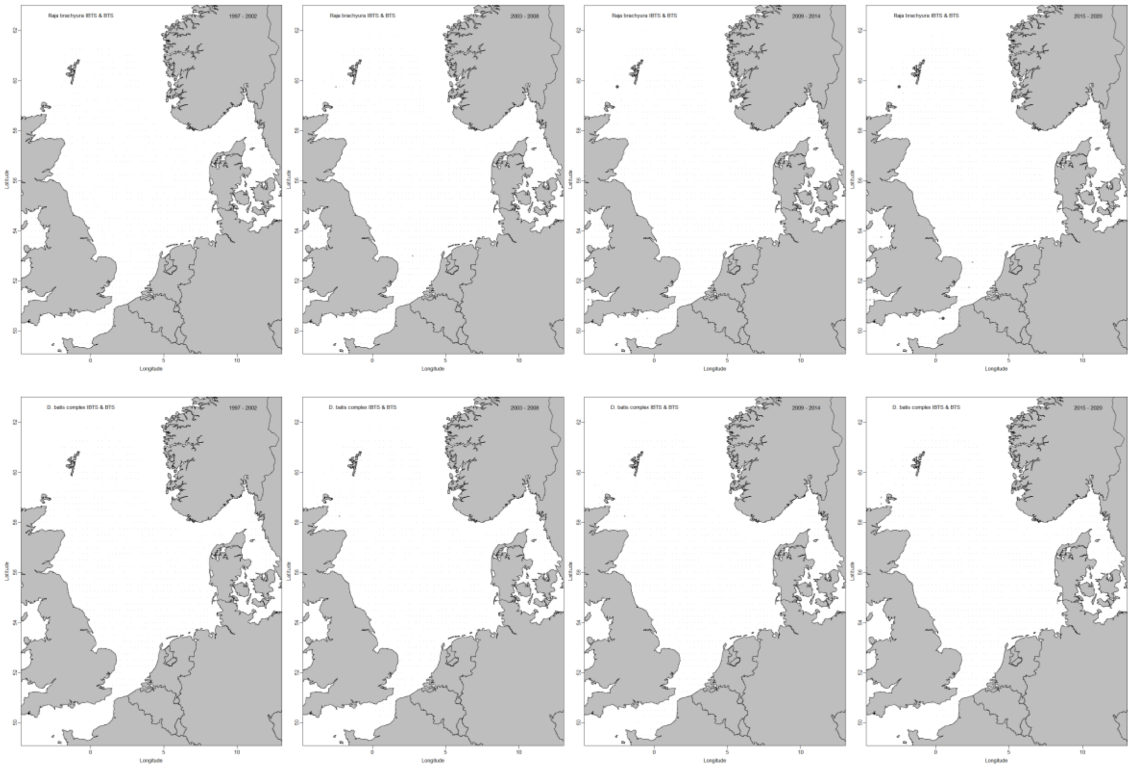

Figure 15.6.10 (continued). Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Distribution plots of the main demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and Eastern Channel. Plots are based on IBTS-Q1, IBTS-Q3, and BTS data. Plots cover four periods: 1997–2002 (left panels), 2003–2008 (centre-left panels), 2009–2014 (centre right panels) and 2015–2020 (right panels). All data are extracted from DATRAS. Data for IBTS are extracted as CPUE per length per hour) on 8 June 2021. CGFS-Q4 data are not included in the plots. Bubble scale is equal in all panels.

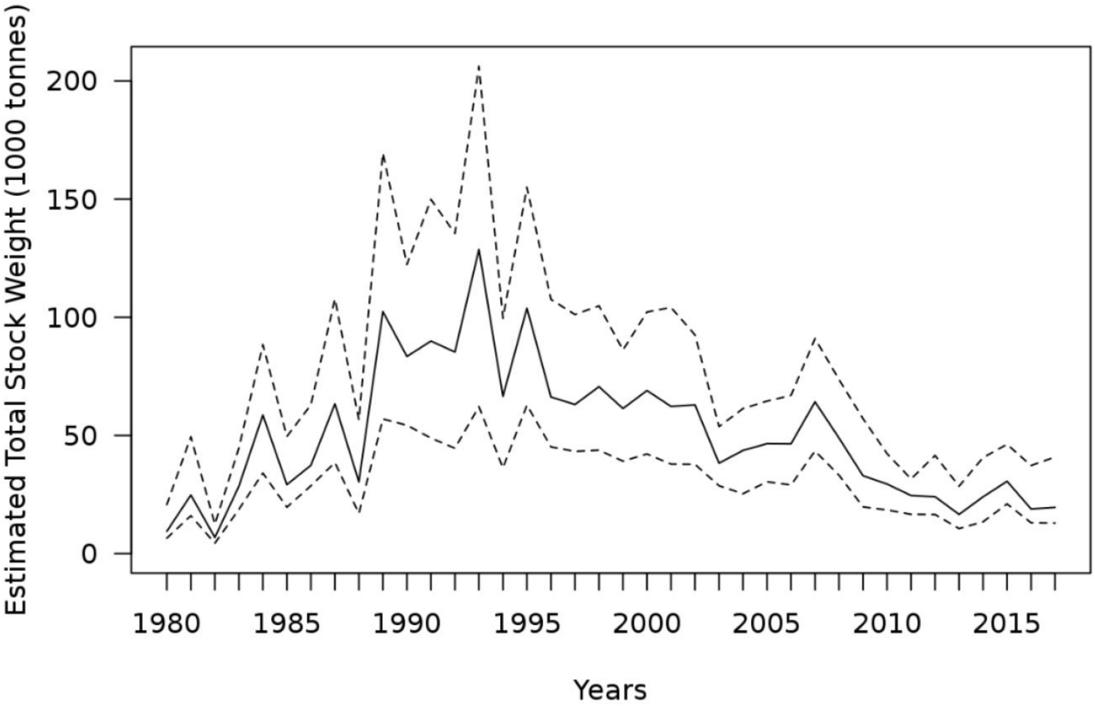

Figure 15.8.1. Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat and eastern Channel. Estimated total stock weight of starry ray (*Amblyraja radiata*) (median – solid line, in 1000 tones) and associated uncertainty (0.025 and 0.975 quantile – lower and upper dotted line). Source: van Overzee *et al.* 2019.

16 Demersal elasmobranchs - Iceland and East Greenland

16.1 Ecoregion and stock boundaries

The elasmobranch fauna off Iceland and Greenland is little-studied and comprises 15 skate and 21 shark species (with six species of chimaeroid also present). The number of species decreases as water temperature decreases, and only a few of these species are common in Icelandic and Greenland waters.

An ecosystem overview for the ecoregion of Icelandic waters has been published and is available at the ICES website:

(http://ices.dk/sites/pub/Publication%20Reports/Advice/2017/2017/Ecosystem_overview-Icelandic_Waters_ecoregion.pdf).

The most abundant elasmobranch species in this ecoregion is starry ray (thorny skate) *Amblyraja radiata*.

In Icelandic waters, other skate species occurring are: Arctic skate *Amblyraja hyperborea,* Jensen's skate *Amblyraja jenseni,* common skate complex, Norwegian skate *Dipturus nidarosienis,* shagreen ray *Leucoraja fullonica*, roughskin skate *Malacoraja spinacidermis,* Krefft's skate, *Malacoraja kreffti*, deep-water ray *Rajella bathyphila*, Bigelow's skate *Rajella bigelowi,* round skate *Rajella fyllae*, sailray *Rajella lintea* (former *D. linteus*) and spinytail skate *Bathyraja spinicauda.*

In Greenland waters, the commonly found skates include *R. fyllae, B. spinicauda* and *A. hyperborea,* with species such as *R. bathyphila*, *M. spinacidermis, R. lintea*, *A. jenseni* and *R. bigelowi* being less frequent (Möller *et al.*, 2010).

Dogfish and sharks in this ecoregion include spurdog *Squalus acanthias* (Section 2); Portuguese dogfish *Centroscymnus coelolepis* and leafscale gulper shark *Centrophorus squamosus* (Section 3); birdbeak dogfish *Deania calcea*, black dogfish *Centroscyllium fabricii*, great lantern shark *Etmopterus princeps*, velvet belly lanternshark *E. spinax,* longnose velvet dogfish *Centroselachus crepidater* and six gill shark *Hexanchus griseus* (Section 5); porbeagle shark *Lamna nasus* (Section 6); basking shark *Cetorhinus maximus* (Section 7); Greenland shark *Somniosus microcephalus* (Section 24); and several scyliorhinid catsharks (Iceland catshark *Apristurus laurussonii,* white ghost catshark *A. aphyodes*, small-eye catshark *A. microps* and mouse catshark *Galeus murinus*).

Chimaeras (rabbitfish *Chimaera monstrosa*, spearnose chimaera *Rhinochimaera atlantica*, large-eyed rabbitfish *Hydrolagus mirabilis*, *H. pallidus*, small-eyed rabbitfish *Hydrolagus affinis*, narrownose chimaera *Harriotta raleighana*) all occur in the area.

Stock boundaries are not known for the species in this area. Neither are the potential movements of species between coastal and offshore areas. Further investigations are necessary to determine potential migrations or interactions of elasmobranch populations within this ecoregion and neighbouring areas.

16.2 The fishery

16.2.1 History of the fishery

Skates and sharks are mainly a bycatch in fisheries, with Iceland being the main fishing nation operating in the ecoregion. Common skate complex is fished with a variety of fishing gears (Figure 16.1a). They used to be regarded as fairly common in Icelandic waters, but landings may now only be about 10% of what was landed 50 years ago. A large part of the landed catch is for local consumption, as the species within the common skate complex are traditional food in Iceland, particularly at Christmas time. The remaining catch is processed and mainly exported.

A. radiata is a bycatch in a variety of fishing gears around Iceland but was usually discarded. Increased landings since the 1990s may be related to an increased retention compensating for a lower abundance of the common skate complex. Landings are reported mainly from the longline fishery (Figure 16.1b). Reported landings have increased from low levels in 1980 to more than 1000 tonnes annually from 1995–2004. Thereafter, landings declined but have increased again to levels exceeding 1700 tonnes in 2012. From 2012 to 2016, landings have gradually reduced to approximately 1250 tonnes in 2016, followed by an abrupt decline in 2017, being ca. 600 tonnes in 2018. In 2019 and 2020, landings slightly increased again, but are not at the same level as observed before 2017. A relatively large proportion of the landings is for local consumption.

16.2.2 The fishery in 2020

No new information.

16.2.3 ICES advice applicable

ICES does not provide advice on these stocks.

16.2.4 Management applicable

There is no TAC for demersal skates in these areas.

16.3 Catch data

16.3.1 Landings

From 1973–2020, 13 countries reported landings of skates, demersal sharks and chimaeras from Divisions 5.a (Iceland) and 14.a and 14.b (East Greenland). Iceland is the main nation fishing in these areas.

Reported landings of skates from Iceland (Division 5.a) and eastern Greenland (Subarea 14) are given in Table 16.1, with these data comprising national landings data provided to WGEF, landings statistics from the Faroese national database (www.hagstova.fo), and data from the ICES database.

Icelandic national data for estimated landings of the common skate complex (1973–2020), *A. radiata* (1977–2020), *R. lintea* (2000–2020) are available. Database entries for all species with national landings for the years 2001–2020 are available.

Prior to 1992, all skates (except *A. radiata* and common skate complex) were reported as '*Raja* rays nei'. Since 1992, when skates have been reported to the species level, *A. radiata* and *Dipturus* *batis*-complex have accounted for about 98% of the annual skate landings. Only small quantities of *L. fullonica*, *R. lintea* and *B. spinicauda* have been reported. Fishers do not usually distinguish between *L. fullonica* and *R. lintea* in Icelandic waters, and so landings of *R. lintea* are likely to be underestimated and landings of *L. fullonica* overestimated (as landings of the latter species, which is relatively rare in Icelandic waters, includes some *R. lintea*). Landings reported as *D. batis*-complex could also sometimes be *R. lintea.* Therefore, official landings on *L. fullonica* will be reported as *Raja* rays nei until this issue is locally resolved.

Reported skate landings peaked at 2500 t in 1951. Since then, the landings of the *D. batis*-complex have decreased but landings of *A. radiata* have increased in later years. Landings of *A. radiata* were under 1000 t but after 2005 increased to about 1800 t in 2012 contributing the bulk of landings of elasmobranchs in this ecoregion (Table 16.1; figures 16.2–16.3). Overall, over 95% of the skate landings came from Division 5.a. The share taken by Iceland from this area increased from <50% in the 1970s to nearly 100% from 1999 onwards.

Information on elasmobranch bycatch in East Greenland waters is unavailable, but several species are probably taken and discarded in fisheries for cod, shrimp and Greenland halibut *Reinhardtius hippoglossoides*.

16.3.2 Discards

No discard data were available.

16.3.3 Quality of catch data

The main skates landing nations in this ecoregion now provide species-specific information, but species identification needs improvement.

16.3.4 Discard survival

No data available to WGEF for the fisheries in this ecoregion.

16.4 Commercial catch composition

No data on the length distribution or sex ratio in commercial landings were available.

16.5 Commercial catch and effort data

No data available.

16.6 Fishery-independent surveys

16.6.1 Surveys in Greenland waters

Since 1998, the Greenland surveys (GR-GHXIVB) have covered the area between 61°45'–67°N at depths of 400–1500 m, although the area between 63–64°N was not covered by the surveys, as the bottom topography was too steep and rough. The surveys are aimed at Greenland halibut, although all fish species are recorded. The surveys use an ALFREDO III trawl (wingspread ≈ 21 m; headline height ≈ 5.8 m; mesh size (cod end) = 30 mm) with rock-hopper ground gear. These data were presented to WGEF in a working paper by Jørgensen (2006) and are summarized in Table 16.2. Another source of survey data in Greenland waters is the German Greenland groundfish survey (GER (GRL)-GFS-Q4), and these data need to be examined.

16.6.2 Surveys in Icelandic waters

The Icelandic autumn groundfish survey (IS-SMH) is the main source of fishery-independent data for demersal elasmobranchs in Icelandic waters (Jakobsdóttir *et al.*, 2020). Further, data can be compiled for some species from other surveys e.g. spring groundfish survey (IS-SMB), shrimp and flatfish surveys undertaken by MFRI.

The IS-SMH survey covers the Icelandic shelf and slope at depths of 20–1500 m. It is a stratified systematic survey with standardized fishing methods. Small-meshed bottom trawls (40 mm in the cod-end) with a rock-hopper ground gear are towed at a speed of 3.8 knots for a predetermined distance of 3 nautical miles (See Björnsson *et al.*, 2007 for a detailed description of methodology).

Catch data and frequency of occurrence for skates from IS-SMH is summarised in Table 16.3. Catch data (number of individuals per survey) of all demersal elasmobranchs, for the years 1996–2020, can be found in Jakobsdóttir *et al.* (2020).

16.7 Life-history information

Published information on life history of skates and rays in Icelandic waters is scarce.

Amblyraja radiata is by far the most abundant elasmobranch species in Icelandic waters, with a widespread distribution over the Icelandic shelf and upper slope (Figure 16.4). Seasonal differences in distributional patterns have been noted, with *A. radiata* much less abundant on the shelf during autumn surveys (IS-SMH) than in spring survey (IS-SMB), and the bulk of catches in IS-SMH is taken on shelf break/slope north and east of Iceland (Figure 16.4 a and b, see also MFRI Technical reports, 2021).

Anecdotal information suggests that *A. radiata* undertakes seasonal migrations in relation to egg-laying activity, but this is unconfirmed. Trawl survey data may provide useful information on catches of viable skate egg cases and/or on nursery grounds.

Length–frequency distributions of *A. radiata* in IS-SMH (Figure 16.5) indicate the majority of specimens are <60 cm L_T. Data on maturity derive from autumn survey allowing for calculations of maturity ogives. Length-at-50%-maturity (L_{50}) is 42.9 cm and 41.0 cm (MFRI, Technical reports, 2021) L_T for males and females respectively (L_{95} for males is 51.1 cm and 50 cm for females). These values are lower in comparison to adjacent waters to the NW Atlantic stock (Templeman, 1987), but larger than observed in the North Sea, where L_{50} is 36.2 and 38.4 cm L_T for males and females, respectively (McCully *et al.*, 2012).

16.8 Exploratory assessment models

Abundance indices and biomass estimates for *A. radiata* have been calculated based on IS-SMB and IS-SMH, with a decreasing trend in large skates (>50 cm) observed (Björnsson *et al.*, 2007). Preliminary survey results indicate stable trends in major size groups in recent years after a period of decline (MFRI, Technical reports, 2021).

16.9 Stock assessment

No assessments have been undertaken for the skates in this ecoregion.

16.10 Quality of assessments

Exploratory analyses of survey trends have been conducted for *A. radiata*. However, the majority of commercial landings data are being taken by gears other than bottom trawl (Figure 16.1) and this should be considered.

16.11 Reference points

No reference points have been proposed for any of these species.

16.12 Conservation considerations

The common skate complex has been found to be vulnerable to exploitation and has been near-extirpated from coastal areas elsewhere in their range (e.g. parts of the Irish and North Seas). Preliminary investigation of the common skate complex in Icelandic waters indicated that the dominant species currently found in Icelandic waters is the smaller *D. batis*. Further investigation into the common skate complex and other large-bodied skates in Iceland and East Greenland is required.

16.13 Management considerations

The elasmobranch fauna off Iceland and Greenland is little studied and comprises relatively few species (21 sharks, 15 skates and six chimaeras). Most of the landings of skates are now reported to species.

The most abundant demersal elasmobranch in the area is *A. radiata*, which is widespread and abundant in this and adjacent waters. Negative survey trends for large size starry rays have been observed (Björnsson *et al*., 2007). Preliminary results of more recent data indicate that after a period of decline, stock trends have been stable for a few years.

16.14 References

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Table 16.1. Demersal elasmobranchs - Iceland and East Greenland. Reported landings of skates from Iceland (Division 5.a) and East Greenland (Subarea 14). Data were updated with landings from ICES historic nominal landings database (ICES, 2016) and national landings data provided to the WG (June 2021). Faroese landings 1990–2015 were extracted from Faroes national statistics database available on www.hagstova.fo *1990–2015: Total catch (live weight). ** Prior to 1992 all skates nei are assumed to belong to common skate complex (see earlier reports).

Scientific name	Nation	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
common skate complex	Iceland	364	275	188	333	442	424	403	196	229	245	185	178	120	108
Amblyraja radiata	Iceland	0	0	0	0	0	0	0	0	0	9	12	46	15	44
Raja rays nei**	Belgium	59	51	62	36	41	23	27	36	28	11	15	15	19	18
	Faeroe Islands	80	56	43	35	75	27	37	21	25	23	73	24	21	0
	Germany	76	41	49	41	37	10	2	1	2	2	4	3	2	1
	Norway	1	0	63	4	2	3	2	3	6	1	10	3	5	0
	UK - England & Wales	385	187	195	106	5	0	0	0	0	0	0	0	0	0
	UK - Scotland	5	8	14	8	0	0	0	0	0	0	0	0	0	0
Total		970	618	614	563	602	487	471	257	290	291	299	269	182	171

		1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
common skate complex	Iceland	130	152	152	222	304	363	274	299	245	181	118	108	80	94
	Norway	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Amblyraja radiata	Iceland	125	39	100	163	286	317	294	1206	1749	1493	1430	1252	996	1076
Leucoraja fullonica	Iceland	0	0	0	0	0	0	2	12	24	19	16	12	21	27
Raja rays nei**	Belgium	22	20	22	6	9	6	3	0	0	0	0	0	0	0
	Faeroe Islands*	8	2	2	16	5	2	3	3	9	2	2	7	5	0
	Germany	0	0	0	1	3	1	2	0	9	0	0	1	0	7
	Norway	0	0	0	0	0	25	8	8	7	10	2	19	8	3
	Portugal	0	0	0	0	0	0	0	0	0	0	1	0	0	0
	UK - Eng+Wales+N.Irl.	0	0	0	0	0	1	2		4	0	0	1	2	0
Total		285	213	276	408	607	715	588	1529	2047	1705	1569	1400	1112	1210

Table 16.1. (continued). Demersal elasmobranchs - Iceland and East Greenland. Reported landings of skates from Iceland (Division 5.a) and East Greenland (Subarea 14). Data were updated with landings from ICES historic nominal landings database (ICES, 2016a) and national landings data provided to the WG. *Faroese landings 1990–2017 were extracted from Faroes national statistics database available on www.hagstova.fo. Total catch (live weight). ** Official reports on *L. fullonica* are likely misidentification and thus, from 2005, these numbers are reported to WG as rays nei.

Scientific name	Nation	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
common skate complex	Iceland	82	59	120	145	166	136	123	126	128	117	125	145	153	141	165	143	147	124	194	160
	Norway	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0
Amblyraja radiata	Iceland	1211	1781	1491	1013	657	530	496	634	866	1026	1416	1978	1847	1625	1397	1273	652	604	963	804
Rajella lintea	Iceland	0	0	10	8	1	8	7	0	8	12	9	9	7	4	11	3	5	4	5	4
***Leucoraja fullonica*	Iceland	37	32	17	23													0			
Raja rays nei	Faeroe Islands*	2	1	0	8	9	16	7	11	6	5	14	5	6	4	0	8	3	3		
	Germany	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0			
	France												0	0	0	0	0	0			
	Iceland	0	0	0	0	16	16	17	4	33	19	17	21	37	14	15	13	10	12	31	17
	Norway	6	5	1	0	0	7	0	1	2	4	4	0	0	0	1	1	0	0	4	
	Portugal	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	Russian Federation	0	0	0	2	6	3	0	0	na	na	0	0	na	na	na	0	0	NA		
	Spain	0	0	15	0	0	0	0	0	0	0		0	0	0	0	0	0	0		
	UK	1	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0		
Raja clavata	France								0	0	0	1	0	0	0	0	0	0	0		
Total		1340	1878	1655	1200	855	726	650	786	1043	1183	1520	2039	1917	1788	1595	1433	817	761	1197	985

Table 16.2. Demersal elasmobranchs - Iceland and East Greenland. Demersal elasmobranch species captured during groundfish surveys at East Greenland (1998–2005) giving the total number, observed maximum weight (kg), depth range (m) and bottom temperature range °C and most northern position (decimal degrees). Source: Jørgensen (2006).

Species	N	Max wt (kg)	Depth range (m)	Temp range (°C)	Maximum latitude
Bathyraja spinicauda	82	61.5	548–1455	0.5–5.6	65.46°N
Rajella bathyphila	57	45.3	476–1493	0.3–4.1	65.44°N
Rajella fyllae	117	4.8	411–1449	0.8–5.9	65.46°N
Amblyraja hyperborea	12	23.4	520–1481	0.5–5.4	65.47°N
Amblyraja radiata	483	22.1	411–1281	0.8–6.6	66.21°N
Malacoraja spinacidermis	3	3.1	1282–1450	2.3–2.7	62.25°N
Apristurus laurussoni	3	0.7	836–1255	1.7–4.3	65.22°N
Centroscyllium fabricii	812	128	415–1492	0.6–5.1	65.40°N
Somniosus microcephalus	9	500	512–1112	1.4–4.9	65.35°N

Table 16.3. Demersal elasmobranchs - Iceland and East Greenland. Catch data of skates and rays in MRI annual autumn groundfish survey at Iceland (Division 5.a), giving the number of individuals caught (N) and the frequency of occurrence (percentage of stations where species was collected, %O). 2011 survey (noted with asterisk) was discontinued and therefore data are incomplete.

	2000		2001		2002		2003		2004		2005		2006		2007		2008		2009		2010	
	N	%O	N	%O	N	%O	N	%O	N	%O	N	%O	N	%O	N	%O	N	%O	N	%O	N	%O
common skate complex	6	<1	1	<1	3	<1	3	<1	1	<1	4	<1	6	1	7	1	7	1	9	1	4	<1
Amblyraja radiata	1589	48	1413	45	1442	49	1379	49	1957	51	1678	53	1716	52	1474	52	1569	48	1590	39	1399	46
Rajella lintea	2	<1	0	0	0	0	0	0	0	0	0	0	2	<1	0	0	0	0	0	0	0	0
Amblyraja hyperborea	110	9	160	9	80	8	88	8	97	9	104	8	120	10	59	10	90	9	103	9	86	10
Rajella fyllae	24	4	54	8	53	8	77	6	37	6	53	7	81	8	44	8	106	5	48	10	70	7
Bathyraja spinicauda	7	2	11	2	10	2	25	1	12	2	16	2	21	2	7	2	18	2	11	2	1	2
Rajella bathyphila	1	<1	0	0	0	0	1	<1	0	0	1	<1	0	0	0	0	2	<1	0	0	0	0
Rajella bigelowi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	<1	0	0	0	0

	2011*		2012		2013		2014		2015		2016		2017		2018		2019		2020	
	N	%O	N	%O	N	%O	N	%O	N	%O	N	%O	N	%O	N	%O	N	%O	N	%O
common skate complex	1	1	0	<1	0	0	5	1	17	2	0	0	4	<1	10	1	4	1	4	<1
Amblyraja radiata	295	42	918	34	1142	41	1289	52	1066	49	1268	48	1026	45	1218	42	159	43	919	48
Rajella lintea	0	0	0	0	0	0	0	0	0	0	1		0	0	0	0	-	0	2	<1
Amblyraja hyperborea	27	8	73	7	63	8	95	9	68	5	79	8	43	5	54	6	21	6	66	7
Rajella fyllae	36	5	24	17	35	4	71	10	30	6	46	6	33	9	41	7	26	7	36	7
Bathyraja spinicauda	2	0	11	1	4	2	11	2	5	1	4	1	5	1	7	1	0	0	2	1
Rajella bathyphila	0	0	0	0	0	0	0	0	0	0	0	0	1	<1	0	0	0	0	0	0
Rajella bigelowi	0	0	0	0	0	0	0	0	1	<1	0	0	1	<1	0	0	0	0	0	0
Malacoraja kreffti									2	<1	3	<1	3	<1	0	0	1	<1	2	<1

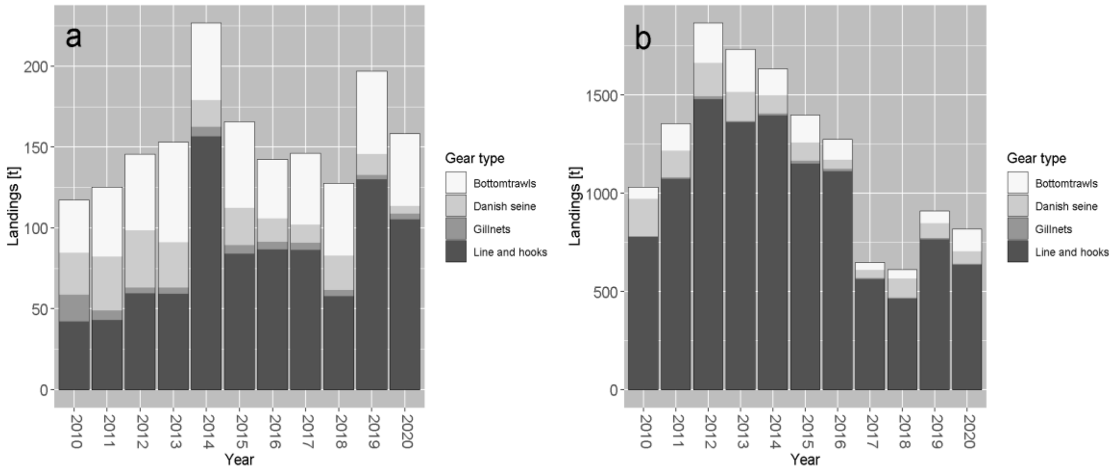

Figure 16.1. Demersal elasmobranchs - Iceland and East Greenland. Icelandic landings of (a) common skate complex and (b) starry ray *A. radiata* by fishing gear). Note different scales at the y-axis.

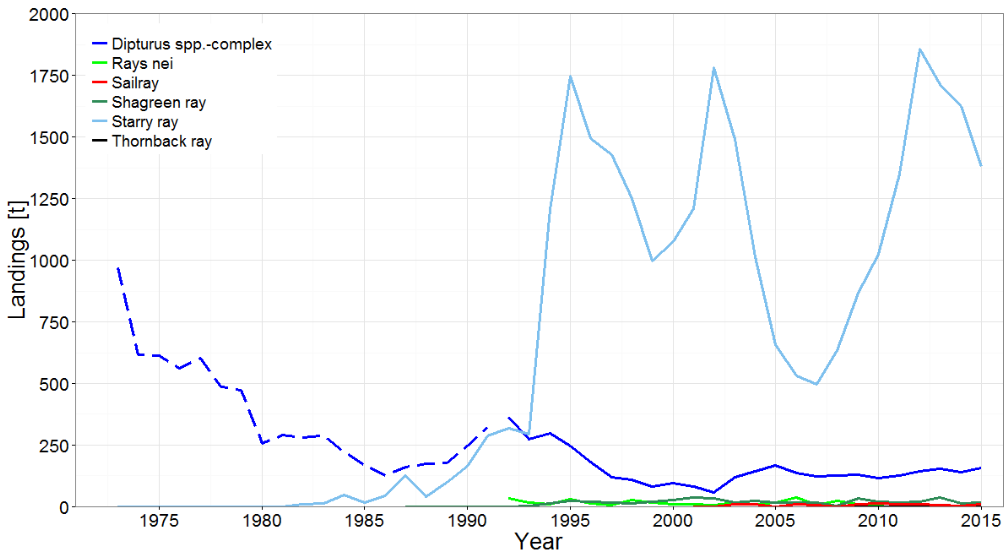

Figure 16.2. Demersal elasmobranchs - Iceland and East Greenland. Landings of skates (Division 5.a and Subarea 14). Prior to 1992, all skates nei are assumed to belong to common skate complex (see earlier reports). WG estimates of the most commonly reported skates, 1973–2015. (ICES, 2016a), national landings data provided to the WG, and Faroese statistical database www.hagstova.fo).

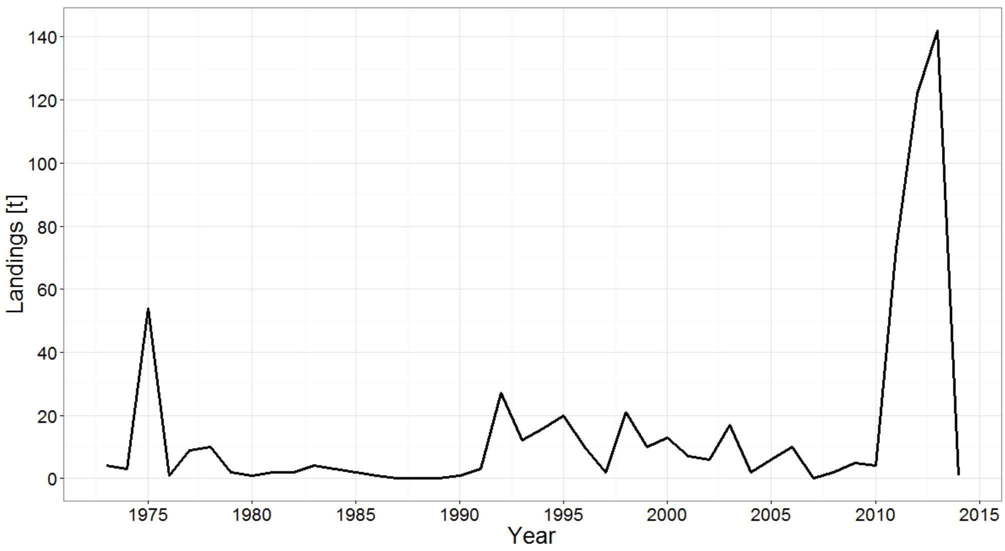

Figure 16.3. Demersal elasmobranchs - Iceland and East Greenland. Combined landings of rays and skates from East Greenland (Subarea 14). The peak landings in 2011–2013 originate from *Amblyraja radiata* (FAO Code RJR). Data from ICES (2016a, b).

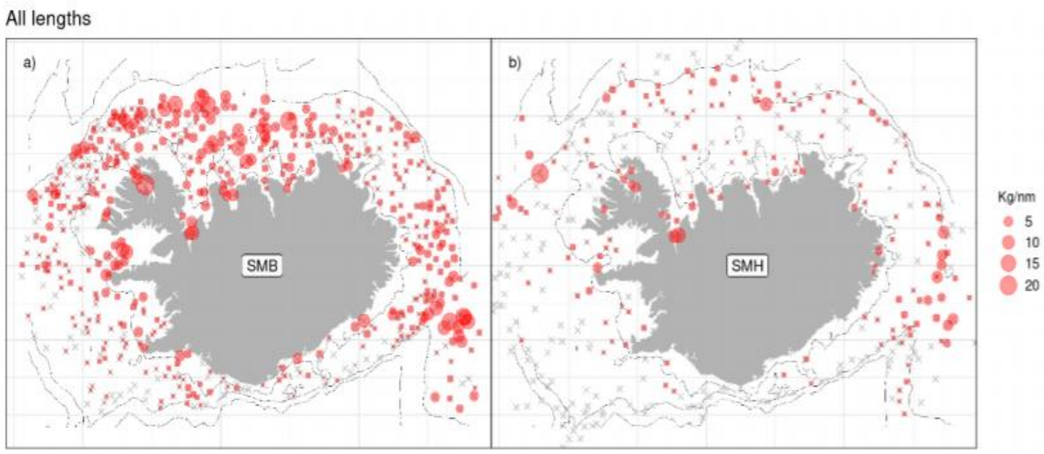

Figure 16.4. Demersal Elasmobranchs - Iceland and East Greenland. Spatial distribution of starry ray *A. radiata* in Icelandic waters (Division 5.a). a: Spring survey (IS-SMB) 2021. b: Autumn survey (IS-SMH) 2020. (see also *MFRI Technical reports 2021*)

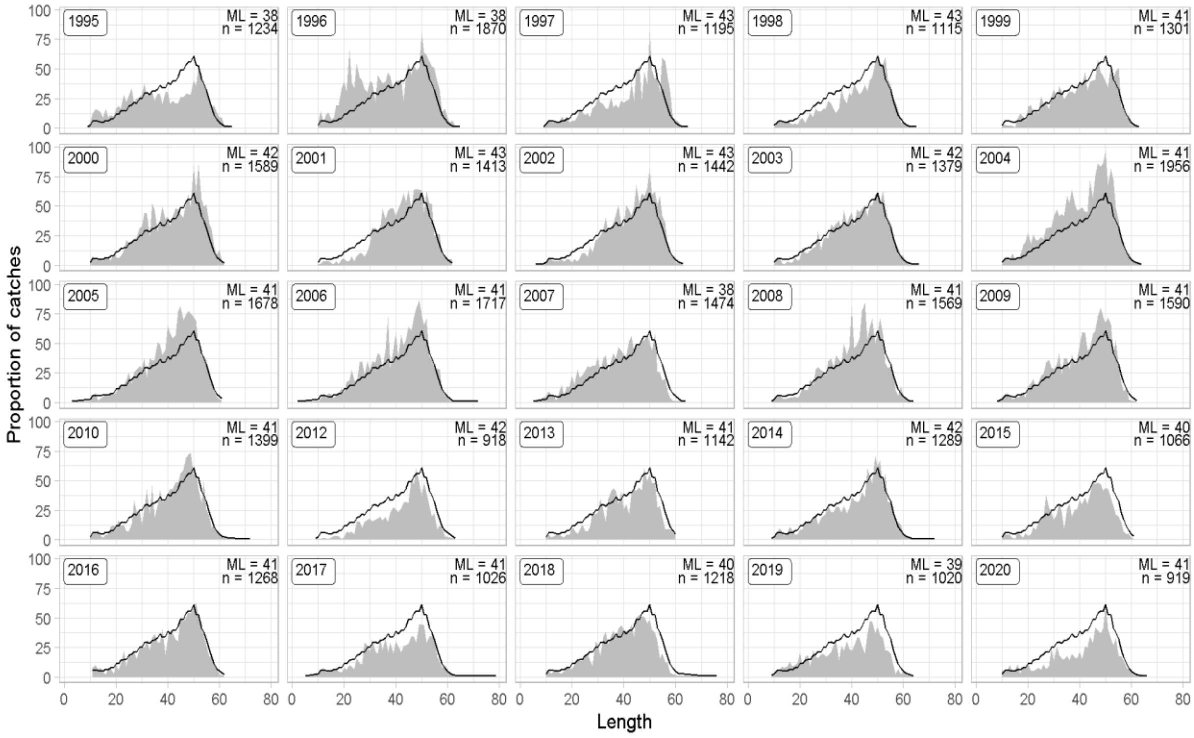

Figure 16.5. Demersal elasmobranchs - Iceland and East Greenland. Length distribution of starry ray *A. radiata* in Icelandic waters (Division 5.a) each year as observed in the annual autumn survey. Broken line denotes average value. Mean length each year is denoted in the upper right corner of each panel. (see also *MFRI Technical reports 2021*)

17 Demersal elasmobranchs at the Faroe Islands

17.1 Ecoregion and stock boundaries

The elasmobranch fauna off the Faroe Islands (ICES divisions 5.b1 and 5.b2) is little studied, though it is likely to be similar to that occurring in the northern North Sea and off NW Scotland and Iceland.

Skates recorded in the area include Arctic skate *Amblyraja hyperborea*, starry ray (thorny skate) *Amblyraja radiata*, common skate complex, long-nosed skate *Dipturus oxyrinchus*, sandy ray *Leucoraja circularis*, shagreen ray *Leucoraja fullonica*, cuckoo ray *Leucoraja naevus*, spotted ray *Raja montagui*, thornback ray *Raja clavata*, round skate *Rajella fyllae* and sailray *Rajella lintea* (formerly *Dipturus linteus*).

Demersal sharks include spurdog *Squalus acanthias* (Section 2), several deep-water species (leaf-scale gulper shark *Centrophorus squamosus*, black dogfish *Centroscyllium fabricii*, birdbeak dogfish *Deania calcea*, longnose velvet dogfish *Centroselachus crepidater*, smallmouth velvet dogfish *Scymnodon obscurus*(sections 2 and 5), Greenland shark *Somniosus microcephalus* (Section 24) and various scyliorhinids, such as mouse catshark *Galeus murinus* and black-mouth catshark *Galeus melastomus* (Section 25).

Several chimaeras also occur in the area: rabbitfish *Chimaera monstrosa*, large-eyed rabbitfish *Hydrolagus mirabilis*, narrownose chimaera *Harriotta raleighana* and spearnose chimaera *Rhinochimaera atlantica*.

Stock boundaries are not known for the species in this area. Neither are the potential movements of species between the coastal and offshore areas. Further investigations are necessary to determine potential migrations or interactions of elasmobranch populations within this ecoregion and neighbouring areas.

17.2 The fishery

17.2.1 History of the fishery

Since 1973, seven countries have reported landings of demersal elasmobranch from Division 5.b, relating mostly to skates. Scottish vessels reported the largest portion of landings in earlier years, but Faroese vessels have reported the greatest quantities since the 1980s. These include trawlers and, to a lesser extent, longliners and gillnetters. Norwegian longliners fishing in this area target ling, tusk and cod. UK vessels include a small number of larger Scottish trawlers that occasionally obtain quota to fish in Faroese waters, and target gadoids and deeper water species. French vessels fishing in this area are probably from the same fleet that execute the mixed deep-water and shelf fishery west of the British Isles. Demersal elasmobranchs likely represent a minor to moderate bycatch in these fisheries.

In 2007, a Russian longliner fished for deep-water sharks in the Faroese Fishing Zone (FFZ) and on the Reykjanes Ridge. The total catch of the elasmobranchs in those and other NEA areas amounted to 483 t (Vinnichenko, 2008; summarised in ICES, 2010).

17.2.2 The fishery in 2020

No new information.

17.2.3 ICES advice applicable

ICES does not provide advice on the skate stocks in this area.

17.2.4 Management applicable

The majority of the area is managed by the Faroes through fishing effort-based system which restricts fishing days for demersal gadoids. Some EU vessels have been able to gain access to the Faroes EEZ where they have been managed under individual quotas for the main target species.

17.3 Catch data

17.3.1 Landings

Landings of skates, not usually identified to species level, are summarised in Table 17.1. French reported landings of common skate complex are unlikely to represent the entire catch, as an unknown quantity is included in the category of unidentified skates and rays. Total skate landings are shown in Figure 17.1.

17.3.2 Discards

The amounts of skates and demersal sharks discarded has not been estimated.

17.3.3 Quality of catch data

Species-specific information for commercial catches is incomplete.

17.3.4 Discard survival

No data available for the elasmobranchs taken in commercial fisheries in this area.

17.4 Commercial catch composition

All skates in Division 5.b, with the exception of French landings, were reported as '*Raja* rays nei' before 2008 (see Table 17.1). There were no port sampling data available to estimate species composition. It is likely that catches include common skate complex, *L. fullonica, R. clavata* and *A. radiata*. No data regarding size composition or sex ratio from commercial landings were available.

17.5 Commercial catch and effort data

No information available to WGEF.

17.6 Fishery-independent surveys

No survey data were available. Magnussen (2002) summarized the demersal fish assemblages from the Faroe Bank, based on the analysis of routine survey data collected by the RV *Magnus Heinason* since 1983. Data on elasmobranchs taken in these surveys are summarized in Table 17.2.

A more detailed analysis of the demersal elasmobranchs taken in Faroese surveys is still to be undertaken.

17.7 Life-history information

No new information. Trawl survey data may provide useful information on catches of viable skate egg cases and/or on nursery grounds.

17.8 Exploratory assessments

No exploratory assessments have been undertaken.

17.9 Stock assessment

No assessments have been conducted due to insufficient data. Analyses of survey data may allow the general status of the more frequent species to be evaluated.

17.10 Quality of assessments

No assessments have been conducted.

17.11 Reference points

No reference points have been proposed for any of these species.

17.12 Conservation considerations

See sections 15.12 and 18.12.

17.13 Management considerations

Total international reported landings of skates declined from 1973–2003 but increased to above the average of the time-series in 2004–2006. Since then, landings declined below the long-term average again and are continuing to decrease in the most recent years. Without detailed information on the fisheries, (including better separation of species, quantities discarded, sizes caught, etc.), it is not possible to provide information on exploitation patterns or the status of stocks.

The elasmobranch fauna off the Faroe Islands is little studied, though it is likely to be somewhat similar to that occurring in the northern North Sea and off Iceland. Further studies to describe the demersal elasmobranch fauna of this region and to conduct preliminary analyses of fishery-independent survey data are required.

The common skate complex has been demonstrated to be vulnerable to exploitation and has been near-extirpated in the Irish and North Seas, further investigation on the common skate complex and other skates in the Faroe Islands is required, including the data analysis from fishery-independent sources.

17.14 References

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Table 17.1. Demersal elasmobranchs at the Faroe Islands. Reported landings of skates from the Faroes area (Division 5.b). Data were updated with nominal landings from ICES database (ICES, 2017) for years 2006–2015 and also contain national landings data provided to the WG. Faroese landings for 1990–2018 were extracted from Faroese national statistics database available on www.hagstova.fo. *Total catch (live weight).

Species	Country	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Raja rays nei	Faroe Islands*	150	95	107	136	164	201	202	198	135	221	211	281	277
	France	0	0	30	57	159	7	3	0	4	2	0	0	0
	Germany	47	33	36	15	23	55	14	7	1	3	3	3	1
	Netherlands	0	0	1	1	0	0	0	0	0	0	0	0	0
	Norway	29	27	37	42	46	64	37	18	21	13	32	35	14
	UK	384	238	250	276	174	104	108	68	11	32	20	1	1
Common skate complex	France	0	0	0	0	0	5	0	0	0	0	0	0	0
Leucoraja naevus	France	0	0	0	0	0	0	1	0	0	0	0	0	0
Raja clavata	France	0	0	0	0	0	0	10	0	0	1	6	23	38
	Total	610	393	461	527	566	436	375	291	172	272	272	343	331

Table 17.1 (continued). Demersal elasmobranchs at the Faroe Islands. Reported landings of skates from the Faroes area (Division 5.b). Data were updated with nominal landings from ICES database (ICES, 2017) for years 2006–2020 and also contain national landings data provided to the WG. Faroese landings for 1990–2018 were extracted from Faroese national statistics database available on www.hagstova.fo. *Total catch (live weight).

Species	Country	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Raja rays nei	Denmark	0	1	0	0	0	0	0	0	0	0	0	0	0
	Faroe Islands*	258	171	92	136	144	207	256	203	167	220	165	185	144
	France	1	6	5	8	5	0	0	0	0	1	1	2	0
	Germany	1	1	0	0	0	1	1	1	3	0	0	0	0
	Norway	22	11	29	84	96	81	37	75	20	14	60	14	45
	UK	0	2	0	1	2	1	5	13	8	7	4	11	7
Common skate complex	France	5	6	7	13	12	5	1	0	0	1	2	3	0
Leucoraja naevus	France	0	2	2	0	0	0	0	0	0	0	0	0	0
Dipturus oxyrinchus	France	0	0	0	0	0	0	0	0	0	0	0	0	0
Raja clavata	France	0	0	0	0	0	0	0	0	0	0	0	0	0
Raja montagui	France	0	0	0	0	0	0	0	0	0	0	0	0	0
Dasyatis pastinaca	France	0	0	0	0	0	0	0	0	0	0	0	0	0
Leucoraja circularis	France	0	0	0	0	0	0	0	0	0	0	0	0	0
Leucoraja fullonica	France	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	287	200	135	242	259	295	300	292	198	243	232	215	196

Table 17.1 (continued). Demersal elasmobranchs at the Faroe Islands. Reported landings of skates from the Faroes area (Division 5.b). Data were updated with nominal landings from ICES database (ICES, 2017) for years 2006–2020 and also contain national landings data provided to the WG. Faroese landings for 1990–2018 were extracted from Faroese national statistics database available on www.hagstova.fo. *Total catch (live weight).

Species	Country	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Raja rays nei	Faroe Islands*	175	0	75	25	98	272	274	238	185	179	150	177	182	198	209
	France	2	0	0	1	5	10	9	20	10	7	6	0	0	0	0
	Germany	1	1	0	0	2	1	0	0	0	0	0	0	0	0	0
	Norway	45	50	21	15	5	0	12	10	16	9	4	11	0	0	0
	UK	6	35	27	12	8	20	8	2	2	2	1	3	0	0	0
Common skate complex	Norway	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0
	France	4	2	2	2	3	5	2	3	1	0	0	0	0	0	0
	UK	0	0	0	0	0	0	0	0	0	0	4	5	0	0	0
Leucoraja naevus	France	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
	UK	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0
Dipturus oxyrinchus	France	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0
Raja clavata	France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
	UK	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Raja montagui	France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Dasyatis pastinaca	France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leucoraja circularis	France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leucoraja fullonica	France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	UK	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0
Rostroraja alba	France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	UK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	233	88	128	55	121	308	305	273	214	201	168	200	182	199	214

Table 17.1 (continued). Demersal elasmobranchs at the Faroe Islands. Reported landings of skates from the Faroes area (Division 5.b). Data were updated with nominal landings from ICES database (ICES, 2017) for years 2006–2020 and also contain national landings data provided to the WG. Faroese landings for 1990–2018 were extracted from Faroese national statistics database available on www.hagstova.fo. *Total catch (live weight). + : <0.5 tonnes. Data for 2020 are preliminary.

Species	Country	2014	2015	2016	2017	2018	2019	2020
Raja rays nei	Faroe Islands*	150	114	126	139	138	170	182
	France	0	5	0	2	6	5	8
	Germany	0	0	0				
	Norway	19	13	23	22	40	30	41
	UK	0	0	0				
Common skate complex	Norway	0	0	0				
	France	0	0	0	+	+		+
	UK	0	1	1	5	1	1	
Leucoraja naevus	France	0	0	0	+		+	+
	UK	0		3	2			+
Raja clavata	France	1	0	0	+		+	+
	UK	0	1	1	+			
Raja montagui	France	3	5	0	1		+	
	UK				+			
Dasyatis pastinaca	France	0	0	0				
Leucoraja circularis	France	0	0	0				
Leucoraja fullonica	France	0	0	0	+	+	+	+
	UK	0	0	0				
Rostroraja alba	France	0	0	0			+	
	Norway						7	1
	Total	173	139	153	171	185	213	232

Table 17.2. Demersal elasmobranchs at the Faroe Islands. Elasmobranchs caught on the Faroe Bank during bottom-trawl surveys (1983–1996) by depth band. Symbols indicate frequency of occurrence in hauls (*: 60–100% of hauls, **: 10–60% of hauls, *: 3–10% of hauls, + : <3% of hauls). Adapted from Magnussen (2002).**

Species	Depth						Total
	<100 m	100–200 m	200–300 m	300–400 m	400–500 m	>500 m	
Galeus melastomus	–	+	*	*	**	**	*
Galeorhinus galeus	–	+	–	–	–	*	+
Squalus acanthias	–	*	*	**	*	**	*
Etmopterus spinax	–	+	–	–	*	**	*
Centroscyllium fabricii	–	–	–	–	*	–	+
Amblyraja radiata	–	–	–	–	–	**	+
Common skate complex	–	*	*	–	–	**	*
Leucoraja fullonica	–	+	+	–	–	*	+
Leucoraja circularis	–	–	*	–	–	–	+
Rajella fyllae	–	+	–	–	–	–	+
Rajella lintea	*	+	–	–	–	–	+
Raja clavata	–	+	–	–	–	–	+
Chimaera monstrosa	*	*	**	***	***	***	**

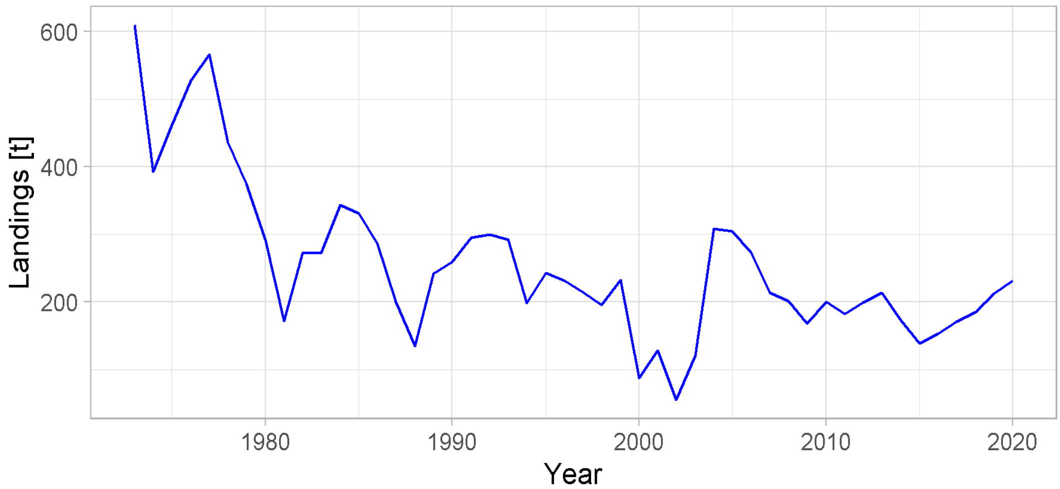

Figure 17.1. Demersal elasmobranchs at the Faroe Islands (Subarea 5.b). Reported landings of skates (1973–2020) based on ICES database (ICES, 2020), national landings data and Faroese national statistics database (www.hagstova.fo).

18 Skates and rays in the Celtic Seas (ICES subareas 6 and 7 (except Division 7.d))

Advice for stocks in this ecoregion was last provided in 2020 and will next be provided in 2022. Therefore, this chapter only contains minor edits and updates to landings tables and figures. The advice for 2021 and 2022 is reproduced in Section 18.2.3.

18.1 Ecoregion and stock boundaries

See Stock Annex.

18.2 The fishery

18.2.1 History of the fishery

See Stock Annex.

18.2.2 The fishery in 2020

Although so far unquantified, COVID-19 is expected to have affected fishing activity in 2020, with national or local restrictions on fishing activity reducing fishing effort for at least some of the year.

TAC and quota regulations were restrictive or near-restrictive for most nations and fisheries. The inclusion of common skate (*Dipturus batis*-complex) on the prohibited species list has resulted in increased discarding or misreporting of this species, especially in areas where they are locally common.

18.2.3 ICES advice applicable

ICES provided advice for several species/stocks in this region in 2020 as summarized in Table below.

Stock	Stock code	Assessment category	Advice basis	Advised Landings in 2021 and 2022
Blonde ray *Raja brachyura* Divisions 7.a and 7.f-g	rjh.27.7afg	5.	Precautionary approach	716 t
Blonde ray *Raja brachyura* Division 7.e	rjh.27.7e	5.	Precautionary approach	266 t
Thornback ray *Raja clavata* Subarea 6	rjc.27.6	3	Precautionary approach	137 t
Thornback ray *Raja clavata* Divisions 7.a and 7.f-g	rjc.27.7afg	3	Precautionary approach	1663 t
Thornback ray *Raja clavata* Division 7.e	rjc.27.7e	5	Precautionary approach	212 t
Small-eyed ray *Raja microocellata* Bristol Channel (Divisions 7.f-g)	rje.27.7fg	3	Precautionary approach	123 t

Stock	**Stock code**	**Assessment category**	**Advice basis**	**Advised Landings in 2021 and 2022**
Small-eyed ray *Raja microocellata* English Channel (Divisions 7.d-e)	rje.27.7de	5	Precautionary approach	40 t
Spotted ray *Raja montagui* Subarea 6 and Divisions 7.b and 7.j	rjm.27.67bj	3	Precautionary approach	51 t
Spotted ray *Raja montagui* Divisions 7.a and 7.e-h	rjm.27.7ae-h	3	Precautionary approach	1033 t
Cuckoo ray *Leucoraja naevus* Subareas 6–7 and Divisions 8.a-b and 8.d	rjn.27.678abd	3	Precautionary approach	3150 t
Sandy ray *Leucoraja circularis* Celtic Seas and adjacent areas	rji.27.67	5	Precautionary approach	34 t
Shagreen ray *Leucoraja fullonica* Celtic Seas and adjacent areas	rjf.27.67	5	Precautionary approach	168 t
Undulate ray *Raja undulata* Divisions 7.b and 7.j	rju.27.7bj	6	Precautionary approach	zero
Undulate ray *Raja undulata* Divisions 7.d-e (English Channel)	rju.27.7de	3	Precautionary approach.	183 t
Common skate *Dipturus batis*-complex (flapper skate *Dipturus intermedius* and blue skate *Dipturus batis*) Subarea 6 and Divisions 7.a–c and 7.e–j	rjb.27.67a-ce-k	6	ICES was not requested to provide advice on fishing opportunities for these stocks.	NA
White skate *Rostroraja alba* in the northeast Atlantic	rja.27.nea	6	Precautionary approach	zero
Other skates Subarea 6 and Divisions 7.a–c and 7.e–j	raj.27.67a-ce-h	6	Insufficient data to provide advice	NA

18.2.4 Management applicable

A TAC for skates in Subarea 6 and divisions 7.a–c and 7.e–k was first established for 2009 and set at 15 748 t. Since then, the TAC has been reduced by approximately 15% (in 2010), 15% (in 2011), 13% (in 2012), 10% (in 2013) and a further 10% (in 2014). In 2017, the TAC was increased by 5%, (including separate TAC for *R. microocellata*), and in 2018, this was increased by a further 15% (including separate TAC for *R. microocellata* and *R. undulata*). In 2020, the TAC was set and reset because of negotiations between the UK and the EU. In April 2021, the TAC was set at 3882 tonnes, excluding an as yet to-be-determined UK quota. In June 2020, an agreement was reached between the EU and UK. The figures below refer to this agreement.

The history of the regulations are as follows:

Year	TAC for EC waters of 6a-b and 7a–c, and 7.e–k	Other measures	Regulation
2009	15 748 t	1,2	Council Regulation (EC) No. 43/2009 of 16 January 2009
2010	13 387 t	1,2,3	Council Regulation (EU) No. 23/2010 of 14 January 2010
2011	11 379 t	1,2,3	Council Regulation (EU) No. 57/2011 of 18 January 2011
2012	9915 t	1,2,3	Council Regulation (EU) No. 43/2012 of 17 January 2012
2013	8924 t	1,2,3	Council Regulation (EU) No. 39/2013 of 21 January 2013
2014	8032 t	1,3,4	Council Regulation (EU) No. 43/2014 of 20 January 2014
2015	8032 t	1,3,5	Council Regulation (EU) No. 2015/104 of 19 January 2015, and amended in Council Regulation (EU) No. 2015/523 of 25 March 2015
2016	8032 t	1,3,6,7	Council Regulation (EU) No 2016/72 of 22 January 2016, and amended in Council Regulation (EU) No. 2016/458 of 30 March 2016
2017	8434 t	1,3,6,8	Council Regulation (EU) No 2017/127 of 20 January 2017,
2018	9699 t	1,3,6,8,9	Council Regulation (EU) No 2018/120 of 23 January 2018,
2019	10 184 t	1,3,6,7,10,11	Council Regulation (EU) No 2019/124 of 30 January 2019,
2020	10 184 t	1,3,6,7,10,11	Council Regulation (EU) No 2020/123 of 27 January 2020
2021	9,675 t	1,3,6,7,10,11,12,13	Council Regulation (EU) No 2021/703 of 26 April 2021, amending Council Regulations 2021/91 and 2021/92 and Written record of fisheries consultations between the United Kingdom and the European Union for 2021

[1] Catches of cuckoo ray *L. naevus*, thornback ray *R. clavata*, blonde ray *R. brachyura*, spotted ray *R. montagui*, small-eyed ray *R. microocellata* sandy ray *L. circularis*, shagreen ray *L. fullonica* should be reported separately.
[2] Does not apply to undulate ray *R. undulata*, common skate *D. batis*, Norwegian skate *D. nidarosiensis* and white skate *Rostroraja alba*. Catches of these species may not be retained on board and shall be promptly released unharmed to the extent practicable. Fishers shall be encouraged to develop and use techniques and equipment to facilitate the rapid and safe release of the species.
[3] Of which up to 5% may be fished in EU waters of Division 7.d.
[4] Shall not apply to undulate ray *R. undulata*, common skate *D. batis* complex, Norwegian skate *D. nidarosiensis* and white skate *Rostroraja alba*. When accidentally caught, these species shall not be harmed. Specimens shall be promptly released. Fishermen shall be encouraged to develop and use techniques and equipment to facilitate the rapid and safe release of the species.

[5] Shall not apply to undulate ray *Raja undulata*. This species shall not be targeted in the areas covered by this TAC. Bycatch of undulate ray in area 7.e exclusively may be landed provided that it does not comprise more than 20 kg live weight per fishing trip and remain under the quotas shown [TAC = 100 t]. This provision shall not apply for catches subject to the landing obligation.
[6] Shall not apply to small-eyed ray *R. microocellata*, except in Union waters of 7.f and 7.g. When accidentally caught, this species shall not be harmed. Specimens shall be promptly released. Fishermen shall be encouraged to develop and use techniques and equipment to facilitate the rapid and safe release of the species. Within the limits of the abovementioned quotas, no more than the quantities of small-eyed ray in Union waters of 7.f and 7.g provided below may be taken [TAC = 188 t]
[7] Shall not apply to undulate ray *R. undulata*. This species shall not be targeted in the areas covered by this TAC. In cases where it is not subject to the landing obligation, bycatch of undulate ray in area 7.e may only be landed whole or gutted, and provided that it does not comprise more than 40 kilograms live weight per fishing trip. The catches shall remain under the quotas shown [TAC = 100 t]. Bycatch of undulate ray shall be reported separately under the following code: RJU/67AKXD.
[8] Shall not apply to undulate ray *R. undulata*. This species shall not be targeted in the areas covered by this TAC. In cases where it is not subject to the landing obligation, bycatch of undulate ray in area 7.e may only be landed whole or gutted. The catches shall remain under the quotas shown [TAC = 161 t]. Bycatch of undulate ray shall be reported separately under the following code: RJU/67AKXD (2017) RJU/07E (2018).
[9] Shall not apply to small-eyed ray (*Raja microocellata*), except in Union waters of 7f and 7g. When accidentally caught, this species shall not be harmed. Specimens shall be promptly released. Fishermen shall be encouraged to develop and use techniques and equipment to facilitate the rapid and safe release of the species. Within the limits of the abovementioned quotas, no more than the quantities of small-eyed ray in Union waters of 7f and 7g (RJE/7FG.) provided below may be taken [TAC = 154 t].
[10] Shall not apply to small-eyed ray (*Raja microocellata*), except in Union waters of 7f and 7g. When accidentally caught, this species shall not be harmed. Specimens shall be promptly released. Fishermen shall be encouraged to develop and use techniques and equipment to facilitate the rapid and safe release of the species. Within the limits of the abovementioned quotas, no more than the quantities of small-eyed ray in Union waters of 7f and 7g (RJE/7FG.) provided below may be taken [TAC = 192 t].
[11] Shall not apply to undulate ray (*Raja undulata*).

[12] Shall not apply to small-eyed ray (*Raja microocellata*), except in Union waters of 7f and 7g. When accidentally caught, this species shall not be harmed. Specimens shall be promptly released. Fishermen shall be encouraged to develop and use techniques and equipment to facilitate the rapid and safe release of the species. Within the limits of the abovementioned quotas, no more than the quantities of small-eyed ray in Union waters of 7f and 7g (RJE/7FG.) provided below may be taken [TAC = 123 t].
[**13**] Special condition: of which up to 5 % may be fished in Union waters of 7d (SRX/*07D.), without prejudice to the prohibitions set out in Articles 20 and 57 of the EU TAC and Quota Regulation 2021 and relevant prohibitions in UK law for the areas specified therein. Catches of cuckoo ray (Leucoraja naevus) (RJN/*07D.), thornback ray (Raja clavata) (RJC/*07D.), blonde ray (Raja brachyura) (RJH/*07D.), spotted ray (Raja montagui) (RJM/*07D.), sandy ray (Raja circularis) (RJI/*07D.) and shagreen ray (Raja fullonica) (RJF/*07D.) shall be reported separately. This special condition shall not apply to small-eyed ray (Raja microocellata) and undulate ray (Raja undulata).

Raja microocellata in Union waters of Subarea 6 and divisions 7.a–c and 7.e–k were initially subject to strict restrictions at the start of 2016, with Council Regulation (EU) 2016/72 of 22 January 2016 stating that: "*When accidentally caught, this species shall not be harmed. Specimens shall be promptly released. Fishermen shall be encouraged to develop and use techniques and equipment to facilitate the rapid and safe release of the species*". However, this was subsequently updated in Council Regulation (EU) 2016/458 of 30 March 2016, whereby the prohibition in landings was revoked for Union waters of 7.f–g, with a precautionary TAC of 188 t being set for this species, within the total skate and ray quota.

A sub TAC of 154 t was similarly applied in 2017 and in 2018, while this was set at 192 t for 2019 and 2020. In 2021, this was set at 123 t.

It is forbidden to retain skates and rays caught on the Porcupine Bank from 1 May–31 May.

There are also mesh-size regulations for target fisheries, the EC action plan for the conservation and management of sharks (EC, 2009), and some local bylaws and initiatives, which were detailed in ICES (2010).

18.2.5 Other management issues

The requirement for EU negotiations with the UK for the first time in 2020/2021 meant that final TAC agreements were not complete at the time by mid-June 2021.

A high-survivability exemption to the Landings Obligation was provided for skates and rays in the Celtic Seas ecoregion until 31 December 2021, with *L. naevus* only exempted until 31 December 2019. An extension to the exemption would only be possible with additional supporting information being provided by the NWWAC. This particularly applies to *L. naevus*, which had a shorter deadline for the provision of evidence of high-survivability than the other species. Several meetings have been held by the NWWAC to discuss and advance this. Best practice guides and measures have been circulated to NWWAC members (2020). The *L. naevus* exemption has been extended to 21 December 2022.

Alternatives to the current TAC system are being explored by the European Commission. A meeting to set Terms of Reference for an STECF request to propose alternatives was held in May 2017. This follows on from proposals by the NWWAC.

Fishermen off North Devon have a voluntary seasonal closed area over what they consider to be a nursery ground.

There are several French measures designed to regulate fishing for *R. undulata* in the English Channel (7.d and 7.e). These measures include: trip limits, closed seasons, restricted licensing of vessels and in 2017 a minimum size of 78 cm (described in Gadenne, 2017, WD).

18.3 Catch data

A data-call in 2017 again followed the procedures recommended by WKSHARK2 (ICES, 2016). This meeting had recommended that recent landings of all elasmobranch species be resubmitted by all ICES members. These landings would be re-evaluated, and declared landings from unlikely locations or species be reassessed or reassigned as required. Decision trees on how to treat problematic records were provided in the workshop report. An ICES data call was issued following this meeting requesting all elasmobranch landings from 2005–2015. The 2017 data call requested a resubmission of final 2015 and preliminary 2016 landings data.

These data were examined by WGEF prior to and during WGEF 2016. Tables 18.1 and 18.2 provides the re-assessed landings by stock for this ecoregion. Some data were resubmitted in 2017, therefore there may be slight differences in landings figures between this and previous reports.

The 2018 and 2019 data calls followed the procedures above.

In 2020, data were provided by means of the ICES InterCatch system for the first time. Further details can be found in Section 1. Intercatch was again used in 2021.

18.3.1 Landings

Landings data for skates (Rajidae) were supplied by all nations fishing in shelf waters within this ecoregion. Data for 2020 are considered provisional. Landings data prior to 2005 are considered variable and uncertain.

Landings by nation are given in Table 18.1. Landings for the entire time-series are shown in Figure 18.1a–c. Where species-specific landings have been provided they have also been included in the total for the relevant year. Although historically there have been around 15 nations involved in the skate fisheries in this ecoregion, only five (France, Great Britain, Belgium, Ireland, and Spain) have continually landed large quantities.

Landings are highly variable, with lows of approximately 14 000 t in the mid-1970s and 1990s, and highs of just over 20 000 t in the early and late 1980s and late 1990s. Although landings have fluctuated over most of the time-series, there has been a steady decline in landings since 2000, at least partly due to the introduction of catch limits. Annual reported landings were less than 10 000 t from 2009–2018, (noting that the TAC was established in 2009). Landings rose above 10 000 t in 2019, for the first time since the TAC was introduced.

West of Scotland (Division 6.a)

Average landings in the early 1990s were about 3000 t. Landings were less than 500 t from 2009–2016, but have been over 500 t per year since then.

Rockall (Division 6.b)

Reported landings from Rockall in the 1990s were about 500 t per year, but have been generally under 200 t since 2009, and less than 100 t in recent years. An exception to this was in 2019 when Norwegian longliners reported 248 t of rays from this area.

The increased landings in the mid-1990s were a result of new landings of 300–400 t per year by Spanish vessels. These no longer appear to take place since only limited Spanish landings have been reported in this area in recent years. It is not clear what proportion of these catches may have been taken from Hatton Bank (6.b.1 and 12.b). One to three Russian longliners fished in this area in 2008–2009, mainly catching deep-water species, including sharks, but also catching 7 t of deep-water skate species.

Irish Sea (Division 7.a)

Reported landings in the Irish Sea vary considerably, and ranged from over 1500 t in 1995 to ca. 5000 t in the late 1980s. Since 2006, annual landings have been < 2000 t, and are now at a low level, although landings began increasing in 2018. The initial decline may be as a result of reduced fishing effort and effort changes because of the cod recovery programme in the area, where whitefish boats have switched to *Nephrops* fishing, with the latter thought to have a lower skate bycatch. Most landings are from Ireland, Great Britain and Belgium.

Bristol Channel (Division 7.f)

Following an increase in reported landings in the mid-1970s, skate landings in Division 7.f have been under 1300 t over the last decade. Landings are predominantly from three countries (Great Britain, France and Belgium).

Western English Channel, Celtic Sea and west of Ireland (divisions 7.b–c, 7.e and 7.g–k)

Landings of skates and rays from divisions 7.b–c, 7.e and 7.g–k estimated by WGEF decreased from 10 000 t in 2005 to 5000 in 2013 and then increased to 6000 in 2019. In 2020, ICES estimated landings were 5100 t, the decrease from 2019 to 2020 may be the consequence of the COVID-19 pandemic.

18.3.2 Skate landing categories

Historically, most skate landings were reported under a generic landing category. There has been a legal requirement to report most skate landings to species level throughout this ecoregion since 2010. On average, 99% of the 2019 landings were reported to species level, with a continuous decline in landings declared in generic categories since 2011. Earlier reports have highlighted various issues regarding the quality of these data (ICES, 2010; 2011; 2012), and this is further discussed in Section 18.4.3.

A study by Silva *et al.* (2012) examined the species-specific data recorded by the UK (England and Wales). Although there were some erroneous or potentially erroneous records, the regional species composition was broadly comparable to that recorded by scientific observers on commercial vessels, and data quality seemed to be improving. Comparable studies to critically evaluate other national data and identify potential errors are still required, to better identify where improved training and/or market sampling may improve data quality.

18.3.3 Discards

WKSHARK3 met in Nantes in February 2017 (ICES, 2017). The objective of the meeting was to examine national discard data and to assess their suitability for use by WGEF.

It was decided that combining national data together to estimate international discards is not suitable. However, if discard data are first raised at national level, it may be possible to combine estimates. However, there are differences in raising methodologies e.g. by fleet, metier, etc., and these must be fully reported and accounted for.

For elasmobranchs, discards are not equivalent to dead catch, as there is some survival, which is probably high for some stocks and fleets. However, survival rate is not accurately known for most species.

Discard data for WGEF were included in the 2018–2021 data calls. Most countries provided raised discards. Raising methodology was considerably different, both between countries and within countries. Raised discard estimates varied by over 200% in some cases, depending on whether they were raised by vessel, fleet or landings. Therefore, discard estimates have not been calculated for skates and rays in this ecoregion.

COVID-19 affected the placing of discard observers on board commercial fishing vessels in 2020. Social distancing regulations meant that observers could not be placed on many vessels, particularly small ones. Therefore, the number of discard samples is likely down on previous years. Fishing activity may also have decreased. In Ireland, a self-sampling scheme was put in place, where discard samples were brought ashore for analysis.

See Stock Annex for historic discard discussions.

18.3.4 Discard survival

There are several ongoing studies on discard survival, e.g, SUMARIS, BIM.

Cuckoo ray has shown high post-capture condition by otter-trawls in the Celtic Sea (BIM, 2019), with 84% showing ‘Excellent’ condition. This may indicate high survivability post-release.

Although the existing European project INTERREG 2 Seas SUMARiS (Sustainable Management of Rays and Skates), is mainly focus on the North Sea and English Channel, results from this project may be applicable to three species with stock units straddling Division 7.d (rju.27.7de, rje.27.7de and rjn.27.678abd). SUMARIS project showed preliminary high survival rates for all species, however the final report is not yet available.

The RAYWATCH project is examining beam trawl-caught species for discard survivability in the Celtic Sea from 2020–2022.

See Stock Annex for further information on discard survivability.

18.3.5 Quality of catch data

Although so far unquantified, COVID-19 is expected to have affected fishing activity in 2020, with national or local restrictions on fishing activity reducing fishing effort for at least some of the year. Discard sampling was likely affected in most countries.

See Stock Annex.

18.4 Commercial catch composition

18.4.1 Size composition

Although length data were not examined this year, length frequencies for the more common species have been shown in earlier studies (ICES, 2007, 2011; Johnston and Clarke, 2011 WD; Silva *et al.*, 2012).

The use of length-based indicators to calculate proxy reference point is further discussed in Section 26.

18.4.2 Quality of data

See Stock Annex.

18.5 Commercial catch and effort data

A case study using French on-board observer data is provided in the stock annex discussing several stocks. The trend for *L. fullonica* is used as supporting information in the advice in 2020, therefore it is retained here. For all others, refer to the stock annex.

Shagreen ray: *Leucoraja fullonica*

rjf.27.67 (Figure 18.2): The species was caught in a relatively high proportion of OTT_DEF. The indicator suggested stability.

18.6 Fishery-independent surveys

Groundfish surveys provide valuable information on the spatial and temporal patterns in the species composition, size composition, sex ratio and relative abundance of various demersal elasmobranchs. Several fishery-independent surveys operate in the Celtic Seas ecoregion. It is noted that these surveys were not designed primarily to inform on the populations of demersal elasmobranchs, and so the gears used, timing of the surveys and distribution of sampling stations may not be optimal for informing on some species and/or life-history stages. However, these surveys provide the longest time-series of species-specific information for skates for many parts of the ecoregion. The distribution of selected skate species caught in surveys coordinated by the IBTS group (see Table 18.4 in the Stock Annex), are shown in the annual IBTS reports.

Descriptions of existing, previous and short-time-series surveys are provided in the Stock Annex.

Updated survey analyses were provided for five surveys in 2020: French EVHOE Groundfish Survey (EVHOE-WIBTS-Q4; Figure 18.3a–e, Figure 18.4d), Irish groundfish survey (IGFS-WIBTS-Q4; Table 18.4a–e; Figure 18.4a, b and d), Spanish Porcupine Groundfish Survey (SpPGFS-WIBTS-Q4; Figure 18.5a–i), the UK (England) beam trawl survey (EngW-BTS-Q3; Table 18.5,

Figure 18.4c and 18.6) and the UK (England) Q1 Southwest ecosystem beam trawl survey (Q1SWECOS previously described as Q1SWBeam[1]; Figure 18.7a–e).

The list of fishery-independent surveys undertaken in this area include (with additional details and information on the history provided in the Stock Annex):

- French EVHOE Groundfish Survey (EVHOE-WIBTS-Q4): 1995–present in Celtic Sea (survey did not take place in 2017).
- Irish Groundfish Survey (IGFS-WIBTS-Q4): 2003–present.
- Spanish Porcupine Groundfish Survey (SpPGFS-WIBTS-Q4): 2001–present.
- UK (Northern Ireland) Groundfish Survey – October (NIGFS-WIBTS-Q4): 1992–present.
- UK (Northern Ireland) Groundfish Survey – March (NIGFS-WIBTS-Q1).
- Scottish West Coast Groundfish Survey Q4 (ScoGFS-WIBTS-Q4): 1990–present.
- Rockall survey (Rock-IBTS-Q3): 1991–present.

Three beam trawl surveys currently operate in this ecoregion (see Stock Annex), surveying the Irish Sea, Bristol Channel, western English Channel and the West of Ireland (additional details and information on the history are provided in the Stock Annex):

- UK (England and Wales) Irish Sea and Bristol Channel beam trawl survey (EngW-BTS-Q3): 1993–present.
- UK (England) beam trawl in western English Channel (Q1SWECOS – previously named Q1SWBeam[2]): 2006–present. This survey extended from the western English Channel (Division 7.e) to the wider Celtic Sea (Divisions 7.f-j) in 2013, however data from those Divisions used as supporting information on species spatial distribution only relates to data from 2014 onwards (Silva *et al.*, 2020).
- Irish monkfish beam trawl survey – IRL-IAMS surveys: 2016 onwards. This beam trawl survey for monkfish and megrim takes place in Q1 and Q2, to the west and northwest of Ireland. Elasmobranchs are caught during this survey, and in future may provide additional indices once a suitable time series is available.

Historical surveys which have been undertaken in the area and can provide past data on elasmobranchs include (with additional details and information on the history provided in the Stock Annex):

- UK (England and Wales) Western Groundfish Survey (EngW-WIBTS-Q4): 2004–2011.
- UK (England) beam trawl in Start Bay, Division 7.e (Eng-WEC-BTS-Q4): 1989–2010.
- Irish maturity survey for commercially important demersal fish: spring 2004–2009.
- Irish deep-water (500–1800 m) trawl survey to the west of Ireland: 2006–2009
- UK Portuguese high headline trawl 1Q (PHHT-Q1): 1982–2003.

18.6.1 Temporal trends in catch rates

The statuses of skates in this ecoregion are based primarily on the evaluation of fishery-independent trawl surveys. The available survey data have been used to evaluate the status of the stocks in 2020 under the ICES approach to data-limited stocks (Section 18.9).

Analyses of length-based data showing temporal trends from the EVHOE survey were shown for several species in 2015 (ICES, 2015a).

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[1] In other ICES documents also referred as ‘UK-Q1-SWBeam’, ‘Eng-WEC-BTS-Q1’ or ‘BTS-UK-Q1’.

[2] See footnote above.

18.6.2 Quality of data

18.6.2.1 Species identification in surveys

There are identification problems with certain skate species that may increase uncertainty in the quality of survey data. *Raja montagui* and *R. brachyura* may be confounded occasionally, and the identification of neonatal specimens of *R. clavata*, *R. brachyura* and *R. montagui* can also be problematic. Recent data are considered more reliable.

Many recent surveys in the ecoregion have attempted to ensure that data collected for the common skate complex be differentiated. In many cases national experts have confirmed which species have been caught in recent years. However, for some past data recorded as *Dipturus batis*, it is uncertain which of the two species (*D. batis* and *D. intermedius*) was caught. It is yet unclear how to clarify for which years and surveys records as *D. batis* refer to the actual species or to the complex.

Several skate species, including some coastal species, occur sporadically in the Celtic Seas ecoregion and may have certain sites where they are locally abundant (e.g. *Raja brachyura*). These may be under-represented in existing surveys (see Stock Annex).

18.6.3 New data

A project is currently taking place in the Tralee Bay area in the South-west of Ireland. The project is to provide data on the species composition, relative abundance and distribution of Skates and Rays for an area off the Irish coast (Dingle Bay, Tralee Bay, Brandon Bay, Shannon Estuary) known to harbour a high diversity of species some of which are critically endangered. Synoptic seasonal surveys using catch and release methods combined with individual identification of fish from photographic records will provide information on movement of these species in this area. There are a number of fisheries in the locality which may impact negatively on these populations. Vessels involved in the tangle net fishery for spiny lobster in particular have a significant by-catch of elasmobranchs. The project is also obtaining data and photographic records of elasmobranch by-catch in this fishery. Some by-catch is released alive where net soak times are low. Mitigation measures such as seasonal or spatial closures or operational measures to reduce soak times to reduce the mortality of elasmobranchs in bottom trawl and net fisheries may be developed from the project. Data for these stocks should be available for the next assessments.

To improve the data collection of skates in the future and provide a solid scientific basis for future catch advice, the EMFF funded Raywatch project was initiated (2020–2022) by ILVO. Raywatch aims to improve the current data collection for skates within the context of the Belgian National Data Gathering Programme (NDGP). The project focusses on collecting biological, catch and vitality data for seven species: thornback ray (*Raja clavata*), blonde ray (*Raja brachyura*), spotted ray (*Raja montagui*), undulate ray (*Raja undulata),* small eyed ray (*Raja microocellata*), sandy ray (*Leucoraja circularis*) and cuckoo ray (*Leucoraja naevus*) in the area of the Western Waters (ICES areas 7.a, f, g, h) and English Channel (ICES areas 7.d, e). Observers join commercial beam trawlers, where total catch weights and length frequencies for the discard and landing fraction will be collected per sex. During a selection of trips, individuals will be scored for their general liveliness ("vitality"). A dead subset of the sampled skates will be taken to the laboratory, where maturity and age will be assessed. In order to improve catch advice for skates in the future, discards and landings data will be extrapolated to fleet level and historical catch data will be integrated as well. A length-based stock assessment model will be made for thornback ray based on the estimated life history parameters, stock structure and landing and discard data collected during the project.

Discard survival studies are taking place in several countries, including Ireland, UK and Netherlands. See Section 18.3.4.

18.7 Life-history information

See Stock Annex.

18.7.1 Ecologically important habitats

See Stock Annex.

18.8 Exploratory assessment models

18.8.1 Productivity-Susceptibility Analysis

See Stock Annex

18.8.2 Previous assessments

See Stock Annex

18.9 Stock assessment

ICES provided stock-specific advice in 2020 for 2021 and 2022. Most stocks belong to Category 3 of the ICES approach to data-limited stocks. Advice is generally therefore based on survey indices. Following decisions made at ADGEF, biomass is now presented instead of numbers of individuals. Therefore from 2020, results and figures may differ from previous reports.

18.9.1 Blonde ray *Raja brachyura* in Subarea 6 and Division 4.a

Raja brachyura has a patchy distribution in Subarea 6. It is not encountered in sufficient numbers in surveys to derive trends in abundance/biomass. The stock is considered to extend to the north western North Sea (Division 4.a). It may also extend along the west coast of Ireland. This Subarea 6 and Division 4.a stock is assessed in North Sea biennial advice years (2015, 2017 and 2019), and was last assessed as a Category 5 stock, using landings data only. WKSKATE (ICES, 2021) examined this stock as a case-study and determined that there was no suitable survey or combination of surveys that could be used in a Category 3 assessment.

18.9.2 Blonde ray *Raja brachyura* in Divisions 7.a and 7.f-g

Raja brachyura has a patchy distribution, and can be locally abundant in some parts of the Irish Sea and Bristol Channel, including off southeast Ireland. Mean catch rates in the Irish Sea and Bristol Channel (e.g. as observed in the UK beam trawl survey) are low and variable. While there was a decrease in abundance in 2015, the stock has been showing an overall increasing trend in the survey. However, it is important to note that this survey does not sample this species effectively, and the survey is not used to provide advice for the stock.

With no reliable survey trend for this stock, it has been assessed since 2016 as a Category 5 stock using landings data. Landings have been stable at 1000–1200 t since 2011.

18.9.3 Blonde ray *Raja brachyura* in Division 7.e

Raja brachyura has a patchy distribution in the western English Channel, and is locally abundant on certain grounds, such as sandbank habitats in and around the Channel Islands, Normano-Breton Gulf and Lyme Bay. The trawl-survey length–frequency data examined for this stock showed a peak for juvenile fish (< 25 cm L_T), with no fish recorded between 24–31 cm L_T and occasional records of larger specimens > 70 cm L_T (Silva *et al*. 2020 WD).

Mean catch rates in a previous beam trawl survey in Great West Bay (Burt *et al.*, 2013) were low, as *R. brachyura* was caught in a relatively low proportion of tows (See Stock Annex).

With no reliable survey trend for this stock, it has been assessed since 2016 as a Category 5 stock using landings data. These reached a peak in 2015 (708 t), dropped to around 500 t per year in 2016 and 2017, but are now at over 800 t per year.

18.9.4 Thornback ray *Raja clavata* in Subarea 6

Earlier analyses of the Scottish surveys in Division 6.a suggested stable/increasing catch trends (1985–2010) although updated analyses were not available.

The IGFS survey shows a generally stable level in the last few years, following one year of peak abundance in 2016 (Figure 18.4a). This index is used in a Category 3 assessment.

18.9.5 Thornback ray *Raja clavata* in Divisions 7.a and 7.f-g

The French EVHOE survey indicated fluctuating catch rates at low levels in the Celtic Sea (Figure 18.3d). Nevertheless, it should also be noted that this survey tends to sample offshore grounds, whereas *R. clavata* is a more inshore species in this area.

The UK (England and Wales) beam trawl survey in divisions 7.a and 7.f (EngW-BTS-Q3) catches reasonable numbers of *R. clavata* and they are observed regularly, although the gear used (4 m beam trawl with chain mat) may have a lower catchability for larger individuals. The survey shows a continuous increasing trend in biomass (Figure 18.6). This survey is used for the Category 3 assessment, as this survey covers the main part of the stock range.

18.9.6 Thornback ray *Raja clavata* in Division 7.e

Analyses of data from a discontinued beam trawl survey in the western English Channel (particularly in the Great West Bay area) was provided in 2012, which suggest stable catch rates. A similar pattern of catches is seen in the current UK beam trawl survey of the western English Channel (Q1SWECOS), with most *R. clavata* captured in Lyme Bay with fewer records elsewhere (Figure 18.7a). Length–frequency showed a peak in the captures of presumably 0-group fish ≤ 20 cm. Although this survey could provide some preliminary estimates of total biomass for Division 7.e, these should be viewed only as 'qualitative assessments'. It shows an increasing trend over the longer time-series, with a recent decrease following a peak in abundance during 2014–2017 and, conflicting signals over the last two years. These analyses were consistent with the survey random stratified design and did not consider the potential effects of catchability and selectivity towards the outputs. Therefore, future work is required to better evaluate and quantify the uncertainty and risks if to use this survey for future quantitative assessment and advice (Silva *et al.*, 2020 WD).

This stock is currently assessed as a Category 5 stock, using landings data. Landings increased steadily since 2009, peaking at 423 t in 2016, followed by a decrease to 372 t in 2017, with the last two years (2018–2019) at a higher level than in 2016 (437 and 490 t, respectively).

18.9.7 Small-eyed ray *Raja microocellata* in the Bristol Channel (Divisions 7.f-g)

Although occasional specimens of *R. microocellata* are caught in Division 7.a, the main concentration of this species is in Division 7.f, with larger individuals occurring slightly further offshore (Division 7.g). The youngest size class is not often taken in surveys, as 0-group fish tend to occur in very shallow water. This species may also occur in some inshore areas of southern and south-western Ireland, although data are limited for these areas.

The UK (England and Wales) beam trawl survey in the Bristol Channel (only those data from stations in 7.f–g were used) has previously indicated stable catch rates. Low catch rates (*ca.* 1 individual per hour) were seen in 2013 (Figure 18.6). This index was automated and updated in 2020 (Silva and Ellis, 2020 WD). Applying the 2 over 5 rule, the mean CPUE for small-eyed ray ≥50 cm L_T decreased from 0.69 kg h^{-1} in 2013–2017 to 0.51 kg h^{-1} in 2018–2019. This survey trend is used in the Category 3 assessment for this stock.

18.9.8 Small-eyed ray *Raja microocellata* in the English Channel (Divisions 7.d-e)

There are also localized concentrations of *R. microocellata* in the English Channel, including around the Channel Islands (Ellis *et al.*, 2011) and Baie of Dournanenez, Brittany (Rousset, 1990), with small numbers taken elsewhere.

Preliminary analyses of data from beam trawl surveys in the western English Channel (particularly in the Great West Bay area) were provided in 2012 (See Stock Annex). The low catch rates are probably related to the patchy distribution of the species in this area. Similarly, Silva *et al.* (2020 WD) identified only a few records of this species in the western English Channel beam trawl survey, with smaller size groups likely to occur in waters shallower than can be surveyed by the research vessel.

With no adequate survey trends available, this stock is assessed under Category 5, using landings data. Landings show a stable trend from 2009–2015, followed by a decrease in 2016 that remained stable for 3 years (ca. 36 t), followed by an increase to 52 t in 2019.

18.9.9 Spotted ray *Raja montagui* in Subarea 6 and Divisions 7.b and 7.j

Raja montagui is a widespread and small-bodied skate and is taken in reasonable numbers in a variety of surveys in the ecoregion. Earlier analyses of the Scottish surveys of 6.a suggested stable/increasing catch trends, although updated analyses are not available.

Catches of *Raja montagui* in the Irish Groundfish survey in Subarea 6 and divisions 7.b and 7.j are relatively stable overall, though, with a large increase in biomass in 2016. This has declined again since 2017. (Figure 18.4b). This survey trend is used in the Category 3 assessment.

18.9.10 Spotted ray *Raja montagui* in Divisions 7.a and 7.e-h

Both the IGFS and the UK beam trawl survey (Figure 18.6) in this stock region show increasing catch rates of this species. Both surveys catch *R. montagui* in reasonable numbers, with mature individuals taken offshore on coarse grounds.

The UK beam trawl survey is currently used to provide the index for the Category 3 assessment, with a stable trend in recent years (Figure 18.4c).

Data from a now-discontinued beam trawl survey in the western English Channel (particularly in the Great West Bay area) were provided in 2012 which suggested that recent catches had increased in relation to the preceding five years, although catch rates were greater at the start of the time-series. A concurrent beam trawl survey of the western English Channel (Division 7.e) and Celtic Sea (ICES divisions 7.f-j) found this species to be more common in the English inshore strata, from Lyme Bay to west of the Scilly Isles. Since survey area extension to the wider Celtic Sea, data from 2014 show that this species can also be found in the Bristol Channel, across the entrance to St George's Channel and along the Irish coast. The survey showed a peak in the length distribution for smaller individuals < 22 cm L_T (WD05 - Silva *et al.*, 2020).

18.9.11 Cuckoo ray *Leucoraja naevus* in Subareas 6 and 7 and Divisions 8.a-b and 8.d

Leucoraja naevus is a widespread and small-bodied skate that is taken in reasonable numbers in a variety of surveys in the ecoregion, especially on offshore grounds. The stock structure of this species is insufficiently known, which makes the interpretation of catch rates in the various surveys more problematic.

The French EVHOE survey showed peaks in relative abundance in 2001–2002 and 2007–2008, with the lowest catches in 2000. The relative abundance in the combined Celtic Sea/Biscay region has been increasing in recent years. However, this survey did not take place in 2017 (Figure 18.3c).

The Spanish survey on the Porcupine Bank indicated a recent slight increase in catches (both in terms of biomass and abundance), although this was from the lowest levels in the time series in 2013 (Figure 18.5b). This survey catches mostly larger fish, with specimens < 30 cm L_T sampled infrequently (Figure 18.5c).

The UK (England and Wales) beam trawl survey in Division 7.a catches small numbers of *L. naevus,* mostly on the offshore stations on coarse grounds. The time series fluctuates, although it is currently showing an increase in recent years (Figure 18.6).

The UK (England) beam trawl in western English Channel and wider Celtic Sea caught this species mostly on grounds to the west of Falmouth, occasionally on the Eddystone grounds and, infrequent in the more easterly parts of the survey area (in Division 7.e). Since 2014, this species has been found on the Celtic Seas strata, extending into the more southern and deeper waters (Silva *et al.*, 2020).The Irish Groundfish Survey mainly catches *L. naevus* in offshore areas. There are annual variations in abundance. In general, biomass trends are similar to those seen in the EVHOE survey, however in 2015, there was a conflicting signal with the EVHOE survey (Figure 18.4d).

The combined index used in this Category 3 assessment, uses the French EVHOE survey and the Irish Groundfish Survey, and indicates that the stock increases following low stock levels in 2012–2013.

18.9.12 Sandy ray *Leucoraja circularis* in the Celtic Seas and adjacent areas

Leucoraja circularis is a larger-bodied, offshore species that may be distributed outside some of the areas surveyed during internationally coordinated surveys, and the distribution of what is assumed to be a Celtic Sea stock will extend into the northern North Sea (Division 4.a) and parts of the Bay of Biscay (Subarea 8). This species is taken only infrequently in most surveys, such as the EVHOE survey (Figure 18.3a) with some nominal records considered unreliable.

Only the Spanish Porcupine Bank survey covers an important part of the habitat of *L. circularis* and catches this species in any quantity (Figure 18.5a). Peak catches were observed in 2007–2008, with a decline following, but catches steadily increased returning to the higher levels observed in this time series, until 2016–2017 when the biomass decreased. Overall, the time-series shows low and variable catch rates, with an increasing trend until 2015, followed by a decrease in recent years (Figure 18.5b). This survey catches a broad size range, with both smaller (< 20 cm L_T) and some larger (> 100 cm L_T) specimens sampled (Figure 18.5c).

Given that the only survey that samples this species effectively only covers a small proportion of the broader stock range, it is not known whether the survey index would be appropriate for the overall stock. Consequently, this stock is assessed as a Category 5 stock, using landings data. Landings of this species were at their highest level in 2009, at near 80 t, but subsequently dropped to around 50–60 t. Landings dropped to their lowest level (38 t in 2015), then increased to 77 t in 2016, before returning to ca. 60 t in 2017. ICES were not requested to provide catch advice for this stock in 2018.

The landings estimated by WGEF are lower than national estimates, as WGEF consider nominal landings of 'sandy ray' from outside their main range to refer to *R. microocellata.*

18.9.13 Shagreen ray *L. fullonica* in the Celtic Seas and adjacent areas

Leucoraja fullonica is a larger-bodied, offshore species that may be distributed outside some of the areas surveyed during internationally coordinated surveys, and the distribution of what is assumed to be a Celtic Sea stock will extend into the northern North Sea (Division 4.a) and parts of the Bay of Biscay (Subarea 8).

This species is taken in small numbers in the EVHOE survey (Figure 18.3b), with catch rates declining. There is a lack of survey for most other parts of the stock area, although the increase in beam trawl surveys in the Celtic Sea may provide more data in the future.

The lack of appropriate survey coverage across the stock range and low, variable catch rates of this species means that a Category 5 assessment using landings data is currently used. Landings in 2016 were at their lowest level (186 t) since 2009, with the peak (301 t) seen in 2010 subsequently declining.

18.9.14 Common skate *Dipturus batis*-complex (flapper skate *Dipturus intermedius* and blue skate *Dipturus batis*) in Subarea 6 and divisions 7.a–c and 7.e–j

Although common skate *D. batis* has long been considered depleted, on the basis of its loss from former habitat and historical decline (Brander, 1981; Rogers and Ellis, 2000), this species has recently been confirmed to comprise two species, and longer term data to determine the extents to which the two individual species have declined are lacking. Although the nomenclature is still to be ratified, the smaller species (the form described as *D. flossada* by Iglésias *et al.*, 2010) will probably remain as *Dipturus batis* and the larger species may revert to *D. intermedius.*

Blue skate *Dipturus batis* occurs in parts of Division 6.b (Rockall Bank) and is the predominant member of the complex in the Celtic Sea (divisions 7.e–k) and it likely extends into Subarea 8. The northern limits to its distribution are unclear.

Flapper skate *D. intermedius* occurs primarily in Division 6.a, parts of Division 6.b, and the northern North Sea (Division 4.a). Smaller numbers are taken in the Celtic Sea (divisions 7.e–k), although its southerly and northerly limits are unknown.

Both species may occur in the intervening areas of divisions 7.a–c, but it is less clear as to which species predominates. The bathymetric ranges of both species are poorly known, as is their western distribution ranges, although unspecified *D. batis* have been reported from the Mid-Atlantic Ridge.

Given that much of the data refer to the species-complex, both species are currently treated together until a suitable time-series of species-specific data are available.

The documented loss of the common skate complex from parts of their former range (e.g. Division 7.a) suggested the complex to be depleted in the Celtic Sea ecoregion.

Analyses of recent data from the Spanish Porcupine Bank Survey indicate low but increasing catch rates for *Dipturus* spp., with the biomass and numbers encountered at their highest level (*ca.* 0.5 individuals and 5 kg per haul) across the time series (Figure 18.5f). The bulk of this catch is comprised of *D. nidarosiensis*, followed by *D. batis* and very few specimens of *D.* intermedius encountered (which only entered the survey time series in 2013 for the first time).

A previous examination of Scottish groundfish survey data (see ICES, 2010b; 2011) indicated some increase in the proportion of hauls in which *D. batis*-complex were observed (Figure 18.7g), although it should be recognized that catch rates were low and with wide confidence intervals. Updated analyses are required.

Given the lack of robust survey data over the stock range, and lack of landings data (due to their prohibited status), a Category 6 assessment was applied to this stock, and trends in stock size or indicator cannot be evaluated.

Recent prohibitions on landings of *D. batis* complex, and *D. nidarosiensis*, have resulted in increases in declared landings of *D. oxyrinchus*. Landings figures and advice refer to *Dipturus* spp., as landings of these species are believed to be confounded.

Particularly high levels of *D. oxyrinchus* were reported in 2019. It is not known whether these reflect an increase in catches of this species, or whether they are confounded with catches of other *Dipturus* species. A revision of the landings table in the 2020 Working Group noted discard information from Spain in the period 2015–2017 were erroneously included in the landings. In addition, Danish landings data for 2017 and 2018 were updated. As such a noticeable change in the landings presented in the current advice and report (Table 18.1 and 18.2) occurred.

18.9.15 Undulate ray *Raja undulata* in divisions 7.b and 7.j

This isolated stock has a very local distribution, mainly in Tralee Bay on the Southwest Irish coast.

There are no trawl surveys that can be used to assess this stock. However, data supplied by Inland Fisheries Ireland (Wögerbauer *et al.*, 2014 WD) shows that tag and recapture rates for *R. undulata* in Tralee Bay (Division 7.j) have significantly declined since the 1970s. Although these data do not allow for potential changes in tagging effort, it suggests that this stock is overexploited (Figure 18.8).

Given the lack of survey data over the coastal habitat for this stock, and a lack of landings data (due to management measures), a Category 6 assessment was applied to this stock, and trends in stock size or indicator cannot be evaluated.

18.9.16 Undulate ray *Raja undulata* in Divisions 7.d-e (English Channel)

There is thought to be a discrete stock of *R. undulata* in the English Channel (divisions 7.d–e), with the main part of the range extending from the Isle of Wight to the Normano-Breton Gulf. This stock is surveyed, in part, by two different beam trawl surveys: the Channel beam trawl survey (see Chapter 15) and the western English Channel (Q1SWECOS, WD05 - Silva *et al.*, 2020), as well as the French Channel Groundfish survey CGFS-Q4 (see Chapter 15). The CGFS-Q4 survey provides a biomass index for undulate ray in Division 7.d, considered representative for the whole stock. The distribution and length ranges of *R. undulata* caught in the western English Channel survey are provided in the Stock Annex. Catch rates are generally variable, partly due to the patchy distribution of this species.

Since 2018, the advice has been based on catches while it was previously based on landings (see stock annex). This stock is managed under a specific TAC. This precautionary TAC has been increasing since 2016 following the biomass index but is considered quite constraining, resulting in high discard rates (0.93 on average in 2018–2019).

Since ICES (2013) commented "*If ICES are to be able to provide more robust advice on the status of this stock, then either dedicated surveys or more intensive sampling of their main habitat in existing surveys should be considered*" there has been a lot of dedicated surveys by French organisations under the Raimouest and RECOAM projects.

LeBlanc *et al.* (2014 WD) summarized the project so far, and showed that *R. undulata* was the main skate species caught in the Norman-Breton Gulf and dominated in coastal waters. Although it occurs throughout much of the English Channel, its distribution appears to be concentrated in the central region. Tagging studies indicate high site fidelity (Stéphan *et al.*, 2014 WD; see Stock Annex). In the Normano-Breton Gulf, 1 488 *R. undulata* were tagged (656 females (29–103 cm L_T) and 832 males (28–99 cm L_T), with a 5% (n = 77) recapture rate. All the skates tagged in a region were recaptured in the same region, and distance travelled was short (< 80 km). Given that the prohibited listing of the species may have deterred reporting of tags in some fisheries, the degree of exchange between the Normano-Breton Gulf and the south coast of England remains unclear. In Division 7.e, 58.4% of the recaptured skates were taken less than 5 km from their release location, and 75.3% were recaptured less than 20 km from the release location. The survey with the best coverage of this stock area is the French Channel Groundfish Survey (CGFS-Q4), where the biomass indicator used in the Category 3 assessment shows the stock to be at the highest level of the time series in 2019, with an index value more than twice as high as the value for 2018.

French *Raja undulata* self-sampling program

In 2016, Council Regulation (EU) 2016/458 of 30 March 2016 amended Regulations (EU) 2015/523 as regards individual TACs for *R. undulata* in ICES divisions.

Under this regulation, only vessels possessing a compulsory fishery license were allowed to catch *R. undulata*. Simultaneously, licensed vessels are obliged to record information on species captured by fishing haul and report to national agencies (Direction des Pêches Maritimes et de l'Aquaculture (DPMA) of the French Ministry for Agriculture and Fisheries). The conditioning of landings of the species upon the possession of a special fishing licence lifted in 2019. This coincides with the end of the self-sampling programme. However, French fishers have been encouraged to report their discards of undulate ray in logbooks since then.

First results from this self-sampling programme are described in more detail in the Working Document (Gadenne, 2017 WD).

Whilst the catch rates in the UK-7d-BTS are too low to provide quantitative advice, this time series shows similar trends to the French CGFS, including the recent increase in catch rates.

In 2018, France made a special request to ICES to re-evaluate the advice for this stock. In particular, further industry-provided data were made available. This special request is further discussed in Annex 8 of this report. WGEF recommends that a benchmark process be undertaken to develop a protocol for incorporating discard data, particularly from industry programmes, into the elasmobranch stock assessments. Since 2018, the advice has been formulated in terms of catch, while it was previously based on landings. For this transition year, and without a precise enough estimate of the survival rate of discarded undulate ray, it was assumed that "all discards survive". Biseau (WD07, 2020) explored the influence of the consideration of a more realistic survival rate of discards based on a minimal estimate derived from a study carried out in the Bay of Bourgneuf (Morfin *et al.*, 2019) during which discarded undulate rays were equipped with acoustic tags. In this analysis, different assumptions on the future discard rate were also made. The main conclusion of this analysis was that accounting for the available information on the survival rate of discards for this species whilst maintaining the level of removals would lead to an increase in the recommended landings. However, this would imply a reduction in the corresponding catch.

WKSHARK5, a workshop which proposed a method to provide fishing opportunities that ensure that exploitation is sustainable when a species has been under moratorium, as is the case with the undulate ray, took place in February 2019. See that report for further details on this stock (ICES, 2020).

An explanatory assessment using length-based indicators was performed for years 2016–2017 and 2018–2019 based on data collected by the onboard observation programme (DCF programme) on French fishing vessels in divisions 7.d-e (WD06 – Baulier, 2020). The assessment used the eight indicator ratios recommended by WKLIFE (ICES, 2015b) and combined catch data from bottom trawls and trammel nets raised to the corresponding fleets. The reference indicator ratio $L_{mean}/L_{F=M}$ (mean length of individuals larger than the length at first capture over the theoretical average length resulting from exploitation with a fishing mortality equal to natural mortality, which is a proxy for F_{MSY}) suggested that the stock was exploited with a fishing mortality lower than F_{MSY}. However, due to deviations from assumptions necessary to the derivation of reference points (especially steady state and knife-edge selectivity), the actual difference between current fishing mortality and F_{MSY} could not be established. Nevertheless, this diagnosis appeared to be robust to the values survival rate of discards applied, the degree of smoothing of the length distribution and the time period considered (2016–2017 or 2018–2019). In addition, the diagnosis for undulate ray turned out to be at least as satisfactory as the ones for thornback and blonde rays in the same ICES divisions.

18.9.17 Other skates in subareas 6 and 7 (excluding Division 7.d)

This section relates to skates not specified elsewhere in the ICES advice. This includes skates not reported to species level and some other, mainly deep-water species throughout the region. It also applies to *R. clavata*, *R. brachyura*, and *R. microcellata* outside the current defined stock boundaries (Table 18.3).

No specific assessment can be applied to this species group, and nominal landings have been shown to have declined dramatically, primarily as a result of improved species-specific reporting of the main commercial skate stocks.

18.10 Quality of assessments

Commercial data are insufficient to proceed using a full stock assessment, although data are improving.

Several updated analyses of temporal changes in relative abundance in fishery-independent surveys were carried out in 2018. These surveys provide the most comprehensive time-series of species-specific information, and cover large parts of the ecoregion. Hence, fishery-independent trawl data are considered the most appropriate data for evaluating the general status of the more common species.

However, it must be stressed that not all skates and rays are well sampled by these surveys, and even some of the most common species (*R. montagui* and *R. clavata*) may only occur in about 30% of hauls. There is also uncertainty regarding the mean catch rates, due to the large confidence intervals.

There are several other issues that influence the evaluation of stock status:

1. The stock identity for many species is not accurately known (although there have been some tagging studies and genetic studies to inform on some species, and the stocks of species with patchy distributions can be inferred from the spatial distributions observed from surveys). For inshore, oviparous species, assessments by ICES division or adjacent divisions may be appropriate, although for species occurring offshore, including *L. naevus*, a better delineation of stock boundaries is required;
2. Age and growth studies have only been undertaken for the more common skate species, although IBTS and beam trawl surveys continue to collect maturity information. Other aspects of their biology, including reproductive output, egg-case hatching success, and natural mortality (including predation on egg-cases) are poorly known;
3. The identification of skate species is considered to be reliable for recent surveys, although there are suspected to be occasional misidentifications;
4. Although fishery-independent surveys are informative for commonly occurring species on the inner continental shelf, these surveys are not well suited for species with localized, coastal distributions (e.g. *R. undulata*, angel shark), patchy distributions (e.g. *R. brachyura*) or outer shelf distributions (e.g. *L. fullonica*).

18.11 Reference points

No reference points have been adopted. Potential methods for establishing precautionary reference points from using the catch-curve method are described in the Stock Annex.

The use of length-based indicators (LBIs) to calculate proxy reference points was discussed, and is further elaborated in Section 26. LBIs for several stocks were estimated by Walker *et al.*, 2018WD and Miethe and Dobby, 2018WD.

18.12 Conservation considerations

In 2015, the IUCN published a European Red List of Marine Fisheries (Nieto *et al.*, 2015). It should be noted the listings below are on a Europe-wide scale for each species, and these listings are not stock-based.

Species	IUCN Red List Category
Amblyraja radiata	Least concern
Dipturus batis	Critically Endangered
Dipturus nidarosiensis	Near Threatened
Dipturus oxyrinchus	Near Threatened
Leucoraja circularis	Endangered
Leucoraja fullonica	Vulnerable
Leucoraja naevus	Least concern
Raja brachyura	Near Threatened
Raja clavata	Near Threatened
Raja microocellata	Near Threatened
Raja montagui	Least concern
Raja undulata	Near Threatened
Rajella fyllae	Least concern
Rostroraja alba	Critically Endangered

In 2016, a red-list for Irish cartilaginous fish (Clarke *et al.,* 2016) was published. This assessed and rated the following species in Irish waters:

Species	Irish red-list category
Dipturus flossada (~batis)	Critically endangered
Dipturus intermedia (~batis)	Critically endangered
Dipturus nidarosiensis	Near Threatened
Dipturus oxyrinchus	Vulnerable
Leucoraja circularis	Near Threatened
Leucoraja fullonica	Vulnerable
Leucoraja naevus	Vulnerable
Raja brachyura	Near Threatened
Raja clavata	Least concern
Raja microocellata	Least concern
Raja montagui	Least concern
Raja undulata	Endangered
Rajella fyllae	Least concern
Rostroaja alba	Critically endangered

18.13 Management considerations

A TAC was only introduced in 2009 for the main skate species in this region. Reported landings may be slightly lower than the TAC, but this can be influenced by various issues (e.g. quota allocation and poor weather). There was evidence that quota was restrictive for some nations from at least 2014.

Raja undulata and *R. microocellata* are currently subjected to limited fishing opportunities, which may disproportionally impact upon some coastal fisheries.

Currently, fishery-independent trawl survey data provide the best time-series of species-specific information. Technical interactions for fisheries in this ecoregion are shown in the Stock Annex.

Main commercial species

Thornback ray, *Raja clavata,* is one of the most important commercial species in the inshore fishing grounds of the Celtic Seas (e.g. eastern Irish Sea, Bristol Channel). It is thought to have been more abundant in the past, and more accurate longer-term assessments of the status of this species are required.

Blonde ray, *Raja brachyura,* is a commercially valuable species. The patchy distribution of *R. brachyura* means that existing surveys have low and variable catch rates. More detailed investigations of this commercially valuable species are required.

Cuckoo ray, *Leucoraja naevus,* is an important commercial species on offshore grounds in the Celtic Sea. Further studies to better define the stock structure are required to better interpret these contrasting abundance trends.

The main stock of small-eyed ray, *Raja microocellata,* occurs in the Bristol Channel, and is locally important for coastal fisheries. Similarly, the English Channel stock of undulate ray *Raja undulata* is also important for inshore fleets.

Spotted ray, *Raja montagui,* is also commercially important, although a higher proportion of the catch of this small-bodied species is discarded in some fisheries. Commercial data for *R. brachyura* and *R. montagui* are often confounded.

Other species

Historically, species such as *L. circularis* and *L. fullonica* may have been more widely distributed on the outer continental shelf seas. These species are now encountered only infrequently in some surveys on the continental shelf, though they are still present in deeper waters along the edge of the continental shelf, and on offshore banks. Hence, studies to better examine the current status of these species in subareas 6–7 should be undertaken.

The larger-bodied species in this area are from the genus *Dipturus*, and data are limited for all species. *Dipturus batis*-complex were known to be more widespread in inner shelf seas historically, and whilst locally abundant in certain areas, have undergone a decline in geographical extent.

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Table 18.1. Skates and rays in the Celtic Seas. Regional total landings (ICES estimates, tonnes) of Celtic Seas skate stocks by nation. Some of these stocks extend outside the Celtic Seas ecoregion and data for these divisions are reported in relevant report chapters.

Country	ICES Stock Code	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
BEL	raj.27.67a-ce-k	1568	1328	1405	413	416	333	227	74	8	1	1	3	3	0	8	7
	rjb.27.67a-ce-k				0	0	0			0	0				0	0	0
	rjc.27.7afg			0	328	216	197	302	441	391	240	350	241	212	197	339	314
	rjc.27.7e				5	2	8	3	4	4	3	9	14	21	14	13	9
	rje.27.7de						3	5	5	7	7	9	9	12	15	16	15
	rje.27.7fg						37	117	124	99	83	106	123	116	121	137	94
	rjf.27.67														0.01		
	rjh.27.4a6					0	0										
	rjh.27.7afg				166	170	210	313	404	406	351	359	313	338	348	520	721
	rjh.27.7e				7	6	3	5	5	6	3	6	11	9	14	10	23
	rji.27.67							0	0	0	0	0	0	2	2	1	1
	rjm.27.67bj						0										
	rjm.27.7ae-h				78	63	55	120	70	3	0	1	7	2	15	15	44
	rjn.27.678abd			0	86	81	70	112	93	97	48	51	27	26	28	25	18
	rju.27.7de												5	24	15	0	0
BEL Total		1568	1328	1405	1083	953	917	1204	1219	1022	737	893	753	763	768	1084	1246
DE	raj.27.67a-ce-k	39	7	26	60	2	4	3	1						0.5	0	0
	rjf.27.67															13	0
DE Total		39	7	26	60	2	4	3	1						0.5	13	0
DK	rjh.27.4a6											0				0	0
DK Total												0				0	0
ES	raj.27.67a-ce-k	2231	2568	2340	1946	206	52	23	15	9	12	45	61	62	357	135	17
	rjb.27.67a-ce-k	24	6	11	28	5	0.2	1	5	23	80	214	232	256	0	0	0
	rjc.27.6					16	2	10	6	23	21	12	12	48	43	69	60

Country	ICES Stock Code	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
	rjc.27.7afg											5	6	9	0.1	0.0	0.1
	rjc.27.7e						0	0									
	rjf.27.67					62	42	29	20	33	20	34	15	22	20	15	14
	rjh.27.4a6					0											
	rji.27.67	86	74	40	7	30	16	22	8	10	5	3	5	11	9	5	2
	rjm.27.67bj				7	7	10	5	0	0	0	1				0.3	
	rjm.27.7ae-h						0				0	0					
	rjn.27.678abd				1	778	480	387	311	373	300	343	372	305	335	295	192
ES Total		2341	2648	2392	1986	1103	603	477	365	471	438	635	701	712	763	520	285
FRA	raj.27.67a-ce-k	2048	1740	1757	1669	548	314	174	160	139	128	123	130	193	126	29	33
	rjb.27.67a-ce-k	351	295	308	414	68	30	15	23	21	32	33	17	19	25	0	0
	rjc.27.6	64	78	73	82	39	24	19	39	28	10	2	1	1	3	13	17
	rjc.27.7afg	379	264	238	181	147	131	133	106	95	107	70	121	147	101	117	80
	rjc.27.7e	95	86	82	64	122	101	114	108	181	224	225	213	176	212	263	264
	rje.27.7de	21	19	19	22	32	28	28	24	26	24	24	8	8	11	17	14
	rje.27.7fg	27	23	18	21	29	21	16	30	30	65	31	5	56	69	92	69
	rjf.27.67	32	25	33	28	144	150	152	147	127	131	151	130	125	129	125	133
	rjh.27.4a6					1					1	1	1	0	1	1	1
	rjh.27.7afg					36	73	131	87	52	170	218	275	257	172	295	277
	rjh.27.7e					56	148	205	169	191	281	304	223	242	396	450	539
	rji.27.67	199	152	185	178	46	35	25	35	26	33	34	37	34	35	25	24
	rjm.27.67bj	13	7	3	4	2	4	7	5	17	53	43	47	40	23	8	1
	rjm.27.7ae-h	1080	902	833	870	785	934	1062	1135	899	912	745	819	661	834	814	576
	rjn.27.678abd	3164	2565	2575	2507	3217	3069	2909	2571	2195	2515	2621	2233	2144	2288	2398	1984
	rju.27.7bj					0				0		0	1	1	0	0	0.3
	rju.27.7de					19	9	20	6	3	10	50	58	79	86	181	159

Country	ICES Stock Code	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
FRA Total		7473	6157	6123	6041	5291	5071	5010	4646	4031	4695	4674	4319	4182	4511	4828	4170
GBR	raj.27.67a-ce-k	2773	2454	2398	1478	508	290	168	153	101	77	46	34	34	30	45	56
	rjb.27.67a-ce-k				96	22	1	19	12	1	63	118	116	112	211	146	5
	rjc.27.6				1	56	61	57	67	120	120	114	147	114	201	233	167
	rjc.27.7afg			0	204	300	371	384	483	416	252	309	274	277	324	322	322
	rjc.27.7e	0	0		3	82	98	98	129	151	151	158	195	173	206	212	189
	rje.27.7de				4	18	40	28	33	32	36	39	19	15	12	20	24
	rje.27.7fg			0	91	157	214	189	208	117	79	78	69	30	55	83	67
	rjf.27.67				13	44	108	97	79	85	55	25	39	21	14	18	17
	rjh.27.4a6				7	5	7	17	4	0	1	3	2	1	3	1	0.3
	rjh.27.7afg		0	0	97	138	226	273	261	262	229	245	245	272	328	404	322
	rjh.27.7e		0		32	159	215	204	175	222	295	396	352	251	323	435	451
	rji.27.67				0	2	0	0	3	25	22	1	35	23	31	4	9
	rjm.27.67bj				5	16	27	32	30	27	29	43	49	43	62	58	1
	rjm.27.7ae-h	0		0	12	38	102	88	85	90	80	70	80	89	93	118	82
	rjn.27.678abd				225	321	421	402	306	269	262	266	254	260	272	289	186
	rju.27.7de				2	2			0			5	22	36	43	63	66
GBR Total		2773	2454	2399	2270	1868	2179	2056	2031	1919	1752	1917	1933	1752	2208	2452	1965
IRL	raj.27.67a-ce-k	2117	1728	1581	1283	1007	547	394	410	243	219	227	230	284	188	148	87
	rjb.27.67a-ce-k			0		2	4	17	1	0	0	9	7	9	9	7	0
	rjc.27.6					3	33	56	69	71	85	87	99	130	90	101	70
	rjc.27.7afg					8	80	126	134	146	191	169	220	232	219	182	192
	rjc.27.7e									0		2		2	4	2	1
	rje.27.7de													2	0	0	0
	rje.27.7fg						0	0	0	0	0	0	0	0	0	0	0
	rjf.27.67						1	6	7	6	4	2	2	49	63	38	23

Country	ICES Stock Code	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
	rjh.27.4a6					0	4	1	1	24	9	9	11	5	23	33	20
	rjh.27.7afg	3	6			5	402	382	407	377	420	351	171	154	228	396	383
	rjh.27.7e								0			2		2	3	0.4	0.7
	rji.27.67						0	4	0							0.2	0
	rjm.27.67bj					1	20	18	25	24	43	28	20	12	19	12	3
	rjm.27.7ae-h					0	19	63	53	40	49	48	41	10	58	64	41
	rjn.27.678abd					12	55	106	108	93	83	79	69	69	115	103	73
	rju.27.7bj														3	0	0
IRL Total		2120	1734	1581	1283	1038	1165	1173	1218	1025	1104	1012	871	961	1022	1088	895
NLD	raj.27.67a-ce-k	0	1	0	0	0	0	0	0	0							
	rjc.27.7afg												0				1
	rjc.27.7e					0	2	1	0	2		0	0	0	0	1	1
	rjh.27.7e								0	0				0		0	0
	rjm.27.7ae-h					0		0		0			0			0	0.1
	rjn.27.678abd						0			0	0			0			0
NLD Total		0	1	0	0	1	2	1	1	2	0	0	0	0	0	1	2
NOR	raj.27.67a-ce-k	50	101	89	77	96	131	62	107	99	157	272	312	153	30	274	331
NOR Total		50	101	89	77	96	131	62	107	99	157	272	312	153	30	274	331
Grand Total		16364	14429	14016	12800	10355	10071	9986	9587	8568	8883	9740	9208	8524	9311	10259	8892

Table 18.2. Skates and rays in the Celtic Seas. Regional total landings (ICES estimates, tonnes) of Celtic Seas skate stocks by stock. Some of these stocks extend outside the Celtic Seas ecoregion and data for these divisions are reported in relevant report chapters.

ICES Stock Code	Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
raj.27.67a-ce-k	BEL	1568	1328	1405	413	416	333	227	74	8	1	1	3	3	0	8	7
	DE	39	7	26	60	2	4	3	1						1		
	ES	2231	2568	2340	1946	206	52	23	15	9	12	45	61	62	357	135	17
	FRA	2048	1740	1757	1669	548	314	174	160	139	128	123	130	193	126	29	33
	GBR	2773	2454	2398	1478	508	290	168	153	101	77	46	34	34	30	45	56
	IRL	2117	1728	1581	1283	1007	547	394	410	243	219	227	230	284	188	148	87
	NLD	0	1	0	0	0	0	0	0	0							
	NOR	50	101	89	77	96	131	62	107	99	157	272	312	153	30	274	331
raj.27.67a-ce-k Total		10826	9926	9597	6928	2783	1671	1052	919	600	594	714	770	729	731	639	531
rjb.27.67a-ce-k	BEL				0	0	0			0	0				0	0	0
	ES	24	6	11	28	5	0.21	1	5	23	80	214	232	256	0	0	0
	FRA	351	295	308	414	68	30	15	23	21	32	33	17	19	25	0	0
	GBR				96	22	1	19	12	1	63	118	116	112	211	146	5
	IRL			0		2	4	17	1	0	0	9	7	9	9	7	0
rjb.27.67a-ce-k Total		375	301	319	538	97	35	52	42	45	175	375	373	396	245	153	5
rjc.27.6	ES					16	2	10	6	23	21	12	12	48	43	69	60
	FRA	64	78	73	82	39	24	19	39	28	10	2	1	1	3	13	17
	GBR				1	56	61	57	67	120	120	114	147	113	201	233	167
	IRL					3	33	56	69	71	85	87	99	130	90	101	70
rjc.27.6 Total		64	78	73	82	114	120	141	181	241	236	213	260	293	337	416	315
rjc.27.7afg	BEL			0	328	216	197	302	441	391	240	350	241	212	197	339	314
	ES											5	6	9	0	0.1	0.1
	FRA	379	264	238	181	147	131	133	106	95	107	70	121	147	101	117	80
	GBR			0	204	300	371	384	483	416	252	309	274	277	324	322	322

ICES Stock Code	Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
	IRL					8	80	126	134	146	191	169	220	232	219	182	192
	NLD												0				0
rjc.27.7afg Total		379	264	238	713	671	780	944	1165	1048	790	903	861	878	840	960	909
rjc.27.7e	BEL				5	2	8	3	4	4	3	9	14	21	14	13	9
	ES						0	0									
	FRA	95	86	82	64	122	101	114	108	181	224	225	213	176	212	263	264
	GBR	0	0		3	82	98	98	129	151	151	158	195	173	206	212	189
	IRL									0		2		2	4	2	1
	NLD					0	2	1	0	2		0	0	0		1	1
rjc.27.7e Total		95	86	82	71	206	208	216	242	339	379	395	423	372	437	490	464
rje.27.7de	BEL						3	5	5	7	7	9	9	12	15	16	15
	FRA	21	19	19	22	32	28	28	24	26	24	24	8	8	11	17	14
	GBR				4	18	40	28	33	32	36	39	19	15	12	20	24
	IRL													2			
rje.27.7de Total		21	19	19	26	50	70	61	62	65	67	72	36	36	38	52	53
rje.27.7fg	BEL						37	117	124	99	83	106	123	116	121	137	94
	FRA	27	23	18	21	29	21	16	30	30	65	31	5	56	69	92	69
	GBR			0	91	157	214	189	208	117	79	78	69	30	55	83	67
	IRL						0	0	0	0	0	0	0	0	0	0.1	0
rje.27.7fg Total		27	23	18	112	187	272	323	362	247	227	216	198	201	245	312	230
rjf.27.67	DE															13	0
	BEL														0	0	0
	ES					62	42	29	20	33	20	34	15	22	20	15	14
	FRA	32	25	33	28	144	150	152	147	127	131	151	130	125	129	125	133
	GBR				13	44	108	97	79	85	55	25	39	21	14	18	17
	IRL						1	6	7	6	4	2	2	49	63	38	23

ICES Stock Code	Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
rjf.27.67 Total		32	25	33	41	250	301	283	253	251	211	212	186	217	225	208	186
rjh.27.4a6	BEL					0	0										0.1
	DK											0					
	ES					0											
	FRA					1					1	1	1	0	1	1	1
	GBR				7	5	7	17	4	0	1	3	2	1	3	1	0.3
	IRL					0	4	1	1	24	9	9	11	5	23	34	20
rjh.27.4a6 Total					7	6	10	17	5	24	10	14	14	6	27	35	21
rjh.27.7afg	BEL				166	170	210	313	404	406	351	359	313	338	348	520	721
	FRA					36	73	131	87	52	170	218	275	257	172	295	277
	GBR		0	0	97	138	226	273	261	262	229	245	245	272	328	404	322
	IRL	3	6			5	402	382	407	377	420	351	171	154	228	396	383
rjh.27.7afg Total		3	6	0	263	350	910	1099	1160	1097	1170	1172	1004	1020	1077	1616	1703
rjh.27.7e	BEL				7	6	3	5	5	6	3	6	11	9	14	10	23
	FRA					56	148	205	169	191	281	304	223	240	396	450	538
	GBR		0		32	159	215	204	175	222	295	396	352	251	323	435	451
	IRL								0			2		2	3	1	1
	NLD								0	0				0		1	1
rjh.27.7e Total			0		39	221	365	414	349	419	579	708	587	504	735	896	1014
rji.27.67	BEL							0	0	0	0	0	0	2	2	1	1
	ES	86	74	40	7	30	16	22	8	10	5	3	5	11	9	5	2
	FRA	199	152	185	178	46	35	25	35	26	33	34	37	34	25	25	24
	GBR				0	2	0	0	3	25	22	1	35	23	31	4	9
	IRL						0	4	0							0	0
rji.27.67 Total		285	226	226	185	78	51	51	46	61	61	38	77	69	77	36	36
rjm.27.67bj	BEL						0										

ICES Stock Code	Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
	ES				7	7	10	5	0	0	0	1	0	0	0	0.3	0
	FRA	13	7	3	4	2	4	7	5	17	53	43	47	40	23	8	1
	GBR				5	16	27	32	30	27	29	43	49	44	62	58	1
	IRL					1	20	18	25	24	43	28	20	12	19	12	3
rjm.27.67bj Total		13	7	3	16	27	62	63	61	68	125	114	116	96	104	79	5
rjm.27.7ae-h	BEL				78	63	55	120	70	3	0	1	7	2	16	15	44
	ES						0				0	0					
	FRA	1080	902	833	870	785	934	1062	1135	899	912	745	819	661	834	814	576
	GBR	0		0	12	38	102	88	85	90	80	70	80	89	93	118	82
	IRL					0	19	63	53	40	49	48	41	10	58	65	41
	NLD					0		0		0			0			0.2	0.1
rjm.27.7ae-h Total		1080	902	833	960	887	1110	1332	1344	1032	1042	864	947	762	1001	1012	741
rjn.27.678abd	BEL			0	86	81	70	112	93	97	48	51	26	26	28	25	18
	ES				1	778	480	387	311	373	300	343	372	305	335	295	192
	FRA	3164	2565	2575	2507	3217	3069	2909	2571	2195	2515	2621	2233	2144	2288	2398	1984
	GBR				225	321	421	402	306	269	262	266	254	259	272	289	186
	IRL					12	55	106	108	93	83	79	69	69	115	103	73
	NLD						0			0	0	0	0	0	0	0	0
rjn.27.678abd Total		3164	2565	2575	2819	4408	4096	3916	3388	3028	3209	3360	2955	2804	3038	3111	2453
rju.27.7bj	IRL														3	0	0
	FRA					0				0		0	1	1	0	0.3	0.3
rju.27.7bj Total						0				0		0	1	1	3	0	0

ICES Stock Code	Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
rju.27.7de	BEL												5	24	15	0.2	0.1
	FRA					19	9	20	6	3	10	50	58	79	86	181	159
	GBR				2	2			0			5	22	36	43	63	66
rju.27.7de Total					2	21	9	20	6	3	10	55	84	139	143	244	225
Grand Total		16364	14429	14016	12800	10355	10071	9986	9587	8568	8883	9740	9208	8524	9311	10259	8892

Table 18.3. Skates and rays in the Celtic Seas. ICES Estimates of landings for other skates and rays in subareas 6–7 (excluding Division 7.d) by species, country, and year (in tonnes). Data revised in 2021.

Country	Species	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
BEL	*Raja brachyura*	0.01	0.01	0.00	0.04	0.00	0.39	0.47	1	2			
	Raja clavata	0.01	0.02	0.00	0.03		0.02	1	0.03	0.08			
	Raja undulata								1	0.23			
	Rajiformes (indet)	416	333	227	74	8	0.46	0.03	1	0.30	0.18	8	7
BEL Total		**416**	**333**	**227**	**74**	**8**	**1**	**1**	**3**	**3**	**0.18**	**8**	**7**
DEU	Rajiformes (indet)	2	4	3	1						1		
DEU Total		**2**	**4**	**3**	**1**						**1**		
ESP	*Raja brachyura*	1			0.21	1							
	Raja clavata	65	23	13	6	5	10	44	59	62	18	14	16
	Raja montagui		3										
	Rajiformes (indet)	139	26	11	9	4	2	1	1		338	121	1
ESP Total		**206**	**52**	**23**	**15**	**9**	**12**	**45**	**61**	**62**	**357**	**135**	**17**
FRA	*Amblyraja hyperborea*				3	0.48	2	18	10	7			
	Amblyraja radiata					4	8	5	9	9			
	Raja brachyura	2	5	6	27	31	25	29	45	62			
	Raja clavata	82	92	45	53	61	46	42	36	27			
	Raja microocellata	0.23	2	0.13	0.15	1	1	2	0.16	1			
	Raja montagui	0.01	0.01	0.11		0.00	0.04	0.02	0.04	58			
	Raja undulata		0.03		0.00			0.04	0.06				
	Rajidae									0.00	4	0.00	
	Rajiformes (indet)	463	215	123	77	42	46	28	31	30	122	29	33
FRA Total		**548**	**314**	**174**	**160**	**139**	**128**	**123**	**130**	**193**	**126**	**29**	**33**
GBR	*Amblyraja hyperborea*					0.11	0.11						1
	Amblyraja radiata			0.05	0.03	1		0.23			0.49		
	Raja brachyura	10	5	4	11	1	1	3	2	2	3	2	1
	Raja clavata	30	55	58	58	35	14	20	27	24	12	18	21
	Raja microocellata	6	8	4	2	11	16	18	1	0.25	1	2	0.3
	Raja montagui											0.03	
	Raja undulata								0.17	0.01	0.19	0.36	0.1
	Rajiformes (indet)	463	223	102	83	54	45	6	4	8	13	23	32
GBR Total		**508**	**290**	**168**	**153**	**101**	**77**	**46**	**34**	**34**	**30**	**45**	**56**
IRL	*Amblyraja radiata*	0.08			0.04		0.05						
	Raja brachyura	5	36	46	47	53	53	40	45	47	40	56	35
	Raja clavata	18	81	88	127	111	117	133	147	151	89	71	39
	Raja microocellata		0.15				0.06		0.30				
	Raja montagui						1	1	0.03	42	0	0	0.3
	Rajella fyllae		1		1								
	Rajiformes (indet)	983	429	259	236	79	49	53	38	43	59	21	14

Country	Species	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
IRL Total		**1007**	**547**	**394**	**410**	**243**	**219**	**227**	**230**	**284**	**188**	**148**	**87**
NLD	*Raja clavata*			0.05									
	Raja montagui		0.10										
	Rajiformes (indet)	0.39		0.08	0.11	0.02							
NLD Total		**0.39**	**0.10**	**0.14**	**0.11**	**0.02**							
NOR	Rajiformes (indet)	96	131	62	107	99	157	272	312	153	30	274	331
NOR Total		**96**	**131**	**62**	**107**	**99**	**157**	**272**	**312**	**153**	**30**	**274**	**331**
Grand Total		2783	1671	1052	919	600	594	714	770	729	731	639	

Table 18.4a. Skates and rays in the Celtic Seas. Biomass estimates (kg per km^2) of assessed stocks from the IGFS-IBTS-Q4 survey, 2005–2019. *Leucoraja naevus*

Year	MgtArea	CatchWgtKg	ci_l	ci_u
2005	6.a	3.341261	0.7631530	5.919370
2006	6.a	2.863412	1.5757870	4.151037
2007	6.a	4.253825	2.3167285	6.190920
2008	6.a	1.550122	0.7289567	2.371288
2009	6.a	2.234281	1.1018169	3.366745
2010	6.a	3.717024	2.0798635	5.354184
2011	6.a	1.785025	0.7836924	2.786359
2012	6.a	2.950243	1.4600642	4.440421
2013	6.a	3.500676	1.5592941	5.442058
2014	6.a	3.246034	0.4422661	6.049802
2015	6.a	0.672508	0.1433472	1.201669
2016	6.a	5.603120	2.7747450	8.431495
2017	6.a	2.360295	1.0888993	3.631690
2018	6.a	3.886602	1.8413575	5.391859
2019	6.a	1.06614	0.2529048	1.880343

Table 18.4b. Skates and rays in the Celtic Seas. Biomass estimates (kg per km^2) of assessed stocks from the IGFS-IBTS-Q4 survey, 2005–2019. *Raja montagui*

Year	MgtArea	CatchWgtKg	ci_l	ci_u
2005	6.&7.bj	3.8203644	0.8772230	6.763506
2006	6.&7.bj	3.5317143	1.7603041	5.303125
2007	6.&7.bj	3.1963185	0.2919647	6.100672
2008	6.&7.bj	2.4079747	1.1541523	3.661797
2009	6.&7.bj	5.0177595	2.1479083	7.887611
2010	6.&7.bj	4.5488637	2.5912639	6.506463
2011	6.&7.bj	6.4196486	3.4717450	9.367552
2012	6.&7.bj	4.0720115	2.3253288	5.818694
2013	6.&7.bj	7.1234651	3.6220724	10.624858
2014	6.&7.bj	9.4745773	3.9045792	15.044575
2015	6.&7.bj	5.9441076	2.9215481	8.966667
2016	6.&7.bj	15.3248874	-3.1670403	33.816815
2017	6.&7.bj	8.9378535	3.9548648	13.920842
2018	6.&7.bj	7.0109626	4.1531268	9.868798
2019	6.&7.bj	6.6001541	2.6351385	10.565170
2005	7.a,e-h	0.7459104	-0.2892318	1.781053
2006	7.a,e-h	3.6461218	0.9412191	6.351025
2007	7.a,e-h	11.1532172	0.8082230	21.498211
2008	7.a,e-h	6.9323503	0.6528146	13.211886
2009	7.a,e-h	8.0424664	2.1113381	13.973595
2010	7.a,e-h	9.9729479	4.0587944	15.887101
2011	7.a,e-h	6.7392692	2.3894273	11.089111
2012	7.a,e-h	7.8776726	3.1958581	12.559487
2013	7.a,e-h	15.4326483	3.1645578	27.700739
2014	7.a,e-h	16.5616727	4.2940963	28.829249
2015	7.a,e-h	20.3186235	7.1949131	33.442334
2016	7.a,e-h	30.2480582	9.2527723	51.243344
2017	7.a,e-h	12.8967985	4.9479571	20.845640
2018	7.a,e-h	31.8726703	8.768211	54.988519
2019	7.a,e-h	17.3224029	2.2585908	32.386217

Table 18.4c. Skates and rays in the Celtic Seas. Biomass estimates (kg per km^2) of assessed stocks from the IGFS-IBTS-Q4 survey, 2005–2017 *Raja brachyura*

Year	MgtArea	CatchWgtKg	ci_l	ci_u
2005	7.a&7.g	0.6014534	-0.3335659	1.5364727
2006	7.a&7.g	0.1426726	-0.1369605	0.4223057
2007	7.a&7.g	1.7877288	-0.2675947	3.8430524
2008	7.a&7.g	3.7541867	-0.5016022	8.0099756
2009	7.a&7.g	0.0000000	0.0000000	0.0000000
2010	7.a&7.g	3.5534812	-0.3123857	7.4193480
2011	7.a&7.g	1.4430961	-1.3853203	4.2715125
2012	7.a&7.g	0.3881487	-0.2841718	1.0604693
2013	7.a&7.g	3.1461458	-1.1897411	7.4820327
2014	7.a&7.g	1.7142022	-0.4667081	3.8951125
2015	7.a&7.g	1.6050991	-0.2292067	3.4394049
2016	7.a&7.g	2.8149362	0.8451547	4.7847177
2017	7.a&7.g	2.2458713	-0.2734638	4.7652064

Table 18.4d. Skates and rays in the Celtic Seas. Biomass estimates (kg per km^2) of assessed stocks from the IGFS-IBTS-Q4 survey, 2005–2019. *Raja clavata*

Year	MgtArea	CatchWgtKg	ci_l	ci_u
2005	6	3.7434568	-0.1480331	7.634947
2006	6	5.9180334	2.4861426	9.349924
2007	6	5.5667234	1.2599530	9.873494
2008	6	7.6147167	2.7638518	12.465582
2009	6	7.2688409	2.7567736	11.780908
2010	6	17.9536507	3.7574574	32.149844
2011	6	13.7808323	4.9685941	22.593070
2012	6	22.8984537	3.2988192	42.498088
2013	6	15.6807027	3.5229155	27.838490
2014	6	12.8470955	1.3826824	24.311508
2015	6	14.3399433	4.0199724	24.659914
2016	6	23.3694853	3.6320664	43.106904
2017	6	15.7783305	7.1192277	24.437433
2018	6	16.21579	5.766965	26.66462
2019	6	16.16309	3.665837	28.66034
2005	7.fg	0.4852387	-0.2500962	1.220573
2006	7.fg	1.1089902	0.1300639	2.087916
2007	7.fg	2.9643871	-0.5731053	6.501880
2008	7.fg	4.3403369	0.5933405	8.087333
2009	7.fg	2.3340468	0.0567745	4.611319
2010	7.fg	4.0709832	-0.4147746	8.556741
2011	7.fg	1.3215369	-0.1738435	2.816917

Year	MgtArea	CatchWgtKg	ci_l	ci_u
2012	7.fg	1.3579023	0.1158664	2.599938
2013	7.fg	2.6173275	-0.5230054	5.757660
2014	7.fg	2.9940930	-0.8974523	6.885638
2015	7.fg	5.3633727	-1.3119085	12.038654
2016	7.fg	5.7414410	0.8802873	10.602595
2017	7.fg	4.5903049	0.2296374	8.950972
2018	7.fg	16.2207595	-4.1526061	36.594125
2019	7.fg	15.5212348	-7.0479097	38.090379

Table 18.4e. Skates and rays in the Celtic Seas. Biomass estimates (kg per km²) of assessed stocks from the IGFS-IBTS-Q4 survey, 2005–2017. *Raja microocellata*

Year	MgtArea	CatchWgtKg	ci_l	ci_u
2005	ICES.27.f-g	0.0000000	0.0000000	0.000000
2006	ICES.27.f-g	2.0380292	-0.5532546	4.629313
2007	ICES.27.f-g	6.9088751	-1.5846139	15.402364
2008	ICES.27.f-g	4.3341235	-0.8869290	9.555176
2009	ICES.27.f-g	0.4155238	-0.3988879	1.229935
2010	ICES.27.f-g	1.5024740	0.0586864	2.946262
2011	ICES.27.f-g	0.7145779	-0.2626957	1.691851
2012	ICES.27.f-g	0.7511249	-0.0690751	1.571325
2013	ICES.27.f-g	1.7806495	-0.5969467	4.158246
2014	ICES.27.f-g	1.8007968	-0.2077030	3.809297
2015	ICES.27.f-g	2.3359211	-0.2738192	4.945661
2016	ICES.27.f-g	4.8460490	-0.8374794	10.529577
2017	ICES.27.f-g	3.3718040	-1.3905964	8.134204

Table 18.4f. Skates and rays in the Celtic Seas. Biomass estimates (kg per km²) of assessed stocks from the IGFS-IBTS-Q4 survey, 2005–2017. *Dipturus batis* and *Dipturus intermedius* combined.

Year	MgtArea	CatchWgtKg	ci_l	ci_u
2005	6&7	0.0647826	0.0190203	0.1105449
2006	6&7	0.3803152	-0.1784847	0.9391151
2007	6&7	0.4278930	-0.0545232	0.9103092
2008	6&7	0.2876187	0.0512355	0.5240019
2009	6&7	0.6405827	0.2032358	1.0779296
2010	6&7	1.8904779	-0.7308948	4.5118505
2011	6&7	1.0733361	-0.4062287	2.5529008
2012	6&7	0.5850637	-0.0695271	1.2396545
2013	6&7	0.6888536	-0.1227879	1.5004950
2014	6&7	0.9398314	0.2384340	1.6412288
2015	6&7	1.2567201	-0.2500285	2.7634687
2016	6&7	3.0762427	-0.7613029	6.9137883
2017	6&7	1.3970494	0.4835118	2.3105869

Table 18.5.a Skates and rays in the Celtic Seas. Biomass estimates (kg per km²) of assessed stocks from the EngW-BTS-Q3survey, 1993–2019. ***Leucoraja naevus***

	CPUE	CPUE	CPUE >= 50 cm Biomass (cpue50Bio)		
	number per hour	kg per hour	*kg per hour	lower.limit.cpue50Bio	upper.limit.cpue50Bio
1993	1.56521739130	0.52982863558	0.2805495930	0.0442842637811807	0.516814922276976
1994	1.77319587629	1.04003396257	0.7334581518	0.255944970691577	1.21097133299459
1995	1.47368421053	0.75033705626	0.4677081143	0.152967004783638	0.78244922382522
1996	1.34736842105	0.52752584593	0.2235253609	0.0657496362671409	0.381301085531509
1997	1.04166666667	0.62398083107	0.4688399162	0.177106476705209	0.760573355751368
1998	1.11578947368	0.48797411904	0.3366904448	0.126043026622171	0.547337863018201
1999	1.75257731959	0.62025928533	0.3341620085	0.105561701344976	0.562762315631701
2000	0.77419354839	0.34581151869	0.2136636726	0.042825637411439	0.384501707751048
2001	1.23711340206	0.61262233340	0.3662549007	0.0992685621795624	0.633241239311363
2002	0.90721649485	0.29903132493	0.1755475901	0.0175064378334215	0.33358874240162
2003	0.92783505155	0.39221405069	0.1679077790	0.0262139087699609	0.309601649151603
2004	1.62500000000	0.54193525081	0.2937186798	0.0801618314712677	0.507275528041643
2005	1.18750000000	0.32954286995	0.1059840317	-0.000160594150776891	0.212128657461432
2006	1.03092783505	0.39647977524	0.1747113090	0.0288583372952765	0.320564280769945
2007	0.93814432990	0.25896622815	0.1102983617	0.010230066	0.210366657606129
2008	0.83395368073	0.41111740358	0.2356705480	0.0373184470793527	0.434022648946133
2009	1.12371134021	0.44097103364	0.2335070236	0.0762954197181952	0.390718627423286
2010	0.62680412371	0.21588113112	0.1294880295	0.0265076007221258	0.232468458372572
2011	0.91666666667	0.55271097883	0.3430747783	-0.00680560006257896	0.692955156675061
2012	0.35051546392	0.11366297453	0.0364605049	-0.0141769728420077	0.087097982683541
2013	0.93377804730	0.38921658365	0.1876143532	0.0310599230436659	0.344168783306712
2014	1.05154639175	0.51116982099	0.3208873025	0.0674088850923328	0.574365719825336
2015	1.03092783505	0.39520473890	0.1659941506	0.0369212295225414	0.295067071707776

	CPUE	CPUE	CPUE >= 50 cm Biomass (cpue50Bio)		
	number per hour	kg per hour	*kg per hour	lower.limit.cpue50Bio	upper.limit.cpue50Bio
2016	0.76041666667	0.27223255869	0.1582434638	0.0420232314319602	0.274463696250751
2017	1.95876288660	0.61370861183	0.2052931051	0.0420057713005318	0.36858043881331
2018	1.35638108781	0.57054229751	0.2407238375	0.0582669413476327	0.423180733659662
2019	1.49484536082	0.40489194792	0.2015715687	0.0573084289063442	0.345834708416645

Table 18.5.b Skates and rays in the Celtic Seas. Biomass estimates (kg per km²) of assessed stocks from the EngW-BTS-Q3 survey, 1993–2019. *Raja brachyura*

	CPUE	CPUE	CPUE >= 50 cm Biomass (cpue50Bio)		
	number per hour	kg per hour	*kg per hour	lower.limit.cpue50Bio	upper.limit.cpue50Bio
1993	0.217391304	0.202926914	0.1269785836	-0.121899440248866	0.375856607434004
1994	0.350515464	0.361539579	0.2963169361	-0.100733695783894	0.693367568006567
1995	0.547368421	0.397228064	0.2778342108	-0.121228001980977	0.676896423679628
1996	0.440789474	0.409321646	0.3553740338	-0.341159072440811	1.05190714002583
1997	0.3125	0.493632623	0.4572130518	-0.224165215645465	1.13859131932599
1998	0.505263158	0.129420715	0.0194946045	-0.0187148203143261	0.0577040293025053
1999	0.762886598	0.394825795	0.2846356009	-0.00895801507297511	0.578229216815799
2000	1.075268817	0.582969453	0.3930191447	-0.220810888161398	1.00684917752671
2001	0.494845361	0.412723449	0.3434749047	-0.2829971762864	0.969946985605843
2002	0.494845361	0.299473316	0.2239284140	-0.0597034924687173	0.50756032043775
2003	0.721649485	0.38135805	0.2443274004	-0.120102453805645	0.608757254704531
2004	1.555107527	0.405724904	0.1163696564	-0.0690933611217857	0.3018326738845
2005	0.729166667	0.549357866	0.4514023829	-0.0329761484911724	0.935780914293191
2006	0.680412371	0.43926959	0.3411269119	0.0224205363826027	0.659833287424341
2007	0.298969072	0.341527271	0.2990834993	-0.0251190520518924	0.623286050561146
2008	0.82382134	0.543261632	0.4293160170	0.029151930618002	0.829480103302409

	CPUE	CPUE	CPUE >= 50 cm Biomass (cpue50Bio)		
	number per hour	kg per hour	*kg per hour	lower.limit.cpue50Bio	upper.limit.cpue50Bio
2009	1.00631859	0.621417119	0.4038532044	-0.00588657755331884	0.813592986274869
2010	0.865979381	0.664957836	0.5157203044	-0.0512517224828438	1.08269233137111
2011	0.962797619	0.749734494	0.5862340720	0.0200404223039115	1.1524277217281
2012	0.995965935	0.371753292	0.1678020905	0.0226252586606098	0.312978922253435
2013	1.308341143	0.560809875	0.3343264204	-0.0420678318695744	0.710720672665972
2014	1.43814433	0.975914777	0.6960153016	-0.106608047107129	1.49863865037693
2015	0.546391753	0.370785528	0.3120654187	0.0430321343678158	0.581098703023767
2016	1.797899763	0.81388907	0.4579647396	-0.150124239977276	1.06605371927591
2017	1.68556701	0.802985092	0.5009889535	0.0207258672167689	0.98125203982872
2018	1.637419282	0.935668638	0.6190722244	0.137965095972936	1.10017935278895
2019	1.696996862	1.499832444	1.2118232393	0.334280453178965	2.089366025

Table 18.5.c Skates and rays in the Celtic Seas. Biomass estimates (kg per km²) of assessed stocks from the EngW-BTS-Q3survey, 1993–2019. *Raja clavata*

	CPUE	CPUE	CPUE >= 50 cm Biomass (cpue50Bio)		
	number per hour	kg per hour	*kg per hour	lower.limit.cpue50Bio	upper.limit.cpue50Bio
1993	3.394409938	2.147491981	1.2590820157	0.413465781	2.10469825044543
1994	2.515463918	1.91860878	1.3790681051	0.63622310148291	2.12191310864556
1995	3.650526316	3.083750445	2.1707238568	1.01555101869268	3.32589669485941
1996	3.962250454	2.659898324	1.7368462209	0.88840333836426	2.58528910350775
1997	4.915331808	2.752639735	1.7154046251	0.673410024004365	2.75739922614728
1998	3.768421053	2.909342987	2.2297194547	1.1887271850968	3.27071172434858
1999	3.399957921	2.512642946	1.8729774437	0.964059960464536	2.78189492696201
2000	3.032258065	1.795110911	1.1668489537	0.485838126889403	1.84785978049978
2001	5.274601687	3.091158416	1.8853662673	0.87187231397991	2.89886022057109
2002	3.572164948	2.694867056	1.8217361065	1.02025455739767	2.62321765560088
2003	3.773195876	2.781402086	2.0496492685	1.09208441586155	3.0072141210445
2004	6.10745614	5.439657812	4.3672541592	0.884130761842763	7.85037755647463
2005	4.068452381	2.64219045	1.6877686689	0.893344433788855	2.48219290406433
2006	4.762886598	2.796041763	1.8118351578	0.806923364003368	2.81674695169522
2007	5.340206186	2.626815277	1.4684218749	0.740072829193358	2.19677092065786
2008	5.499922082	3.112719231	2.0562069357	1.05079932495056	3.06161454638711
2009	6.195298614	3.80590701	2.6161785245	1.62099099226411	3.61136605666566
2010	7.506896552	3.956040131	2.5807912526	1.62204003971039	3.53954246546399
2011	7.494276557	3.35495877	1.7946347953	1.04531741403541	2.54395217648489
2012	8.279772485	3.669060669	1.9290772487	1.22966112433634	2.62849337307193
2013	12.07999063	5.273265802	3.2558764288	2.1004684638374	4.4112843938569
2014	9.032349804	5.381660099	3.4214251798	2.14405489138188	4.69879546824112
2015	9.261878328	4.118343152	2.1751071033	1.25747412558516	3.09274008107204
2016	13.86401285	7.261015872	4.6353006357	2.97200526590177	6.29859600545403

	CPUE	CPUE	CPUE >= 50 cm Biomass (cpue50Bio)		
	number per hour	kg per hour	*kg per hour	lower.limit.cpue50Bio	upper.limit.cpue50Bio
2017	13.08247423	8.163355637	5.4703248523	3.69235371460706	7.24829598994847
2018	16.87255013	10.03634576	6.7907215633	4.41007716869564	9.17136595788654
2019	15.61168385	10.11636979	6.9588077026	4.76673558679735	9.15087981832416

Table 18.5.d Skates and rays in the Celtic Seas. Biomass estimates (kg per km^2) of assessed stocks from the EngW-BTS-Q3survey, 1993–2019. *Raja microocellata*

	CPUE	CPUE	CPUE >= 50 cm Biomass (cpue50Bio)		
	number per hour	kg per hour	*kg per hour	lower.limit.cpue50Bio	upper.limit.cpue50Bio
1993	0.848484848	1.209323294	1.054986582	0.153682658637028	1.95629050537132
1994	1.272727273	2.184432188	1.882180765	0.44001180511436	3.32434972469539
1995	2.679435484	2.94074998	2.26960381	0.315474599845468	4.22373301928702
1996	1.575757576	0.864876196	0.529097288	-0.02183554638712	1.08003012243971
1997	2.394021739	2.91835051	2.294425932	0.775885312637334	3.81296655076254
1998	5.096774194	3.77811973	2.557688943	0.66331962705189	4.45205825847978
1999	3.181818182	3.322263435	2.542161923	1.07022307698618	4.01410076960205
2000	2.375	1.615072133	0.823467294	0.153737439072618	1.49319714801453
2001	2.848484848	2.732879935	1.902478669	0.3974389700647	3.40751836804715
2002	2.666666667	2.88657629	2.316377473	1.07386552201255	3.55888942458746
2003	2.060606061	1.90542341	1.316221172	0.249155610552703	2.38328673250998
2004	3.458211144	2.407014926	1.600518256	0.166629823242332	3.03440668818799
2005	2.181818182	2.330122503	1.750538876	0.557089063336891	2.94398868825122
2006	2.909090909	1.495921372	0.514081152	0.0803558601456727	0.947806444423408
2007	2.787878788	1.451565151	0.535629664	0.0309380937003715	1.04032123399294
2008	2.484848485	1.145102729	0.512381043	0.127876518709268	0.896885567510747
2009	3.086999022	1.849703514	0.774428227	0.126689058847372	1.42216739551718

	CPUE	CPUE	CPUE >= 50 cm Biomass (cpue50Bio)		
	number per hour	kg per hour	*kg per hour	lower.limit.cpue50Bio	upper.limit.cpue50Bio
2010	2.121212121	1.599401064	1.061746829	-0.047396509885677	2.17089016888035
2011	2.909090909	1.619131371	0.785369001	0.0510074158220799	1.51973058586688
2012	2.848484848	1.498667667	0.582842161	0.109941334286113	1.05574298775392
2013	1.052341598	0.625881192	0.284645797	-0.0426558421948529	0.611947436073969
2014	1.393939394	1.128631343	0.656546592	-0.264119299361096	1.5772124840215
2015	2.03030303	0.885628953	0.347916736	-0.165833969250302	0.861667441138694
2016	1.818181818	1.019499503	0.577420556	0.0330601524766504	1.12178095905603
2017	2.909090909	2.097341849	1.601173865	0.435791288563933	2.76655644172408
2018	1.818181818	0.986748046	0.596929422	-0.0927325829212117	1.28659142687332
2019	1.696969697	0.796677248	0.426715474	-0.253315586662374	1.106746535

Table 18.5.e Skates and rays in the Celtic Seas. Biomass estimates (kg per km²) of assessed stocks from the EngW-BTS-Q3survey, 1993–2019. *Raja montagui*

	CPUE	CPUE	CPUE >= 50 cm Biomass (cpue50Bio)		
	number per hour	kg per hour	*kg per hour	lower.limit.cpue50Bio	upper.limit.cpue50Bio
1993	2.178571429	0.90029457	0.520218282	0.218798183520085	0.821638380964473
1994	1.75257732	0.503657603	0.23035323	0.00430983199998111	0.456396627357119
1995	2.294736842	1.078310211	0.620751317	0.207901040913339	1.03360159274587
1996	2.525	1.150903064	0.697683821	0.16307943578072	1.23228820600648
1997	2.625	1.031405373	0.456071723	0.0919425025287939	0.82020094332244
1998	2.463157895	0.63428519	0.16645206	0.0123752355459547	0.320528883790338
1999	3.600673259	1.105423094	0.555816369	0.0720010815674258	1.03963165597383
2000	3.247311828	0.891819124	0.304454718	0.0703923633034616	0.538517073270863
2001	3.690721649	1.245088983	0.453343222	0.16024496413256	0.746441479048517
2002	2.907216495	1.150581829	0.588692078	0.203598071456954	0.973786085301882

	CPUE	CPUE	CPUE >= 50 cm Biomass (cpue50Bio)		
	number per hour	kg per hour	*kg per hour	lower.limit.cpue50Bio	upper.limit.cpue50Bio
2003	4	1.164384444	0.518745742	0.155183845174848	0.882307638431262
2004	6.020863881	1.540221813	0.584668684	0.258296280410702	0.911041087056985
2005	3.541666667	0.827420962	0.249555302	0.0872972367407633	0.411813366273292
2006	3.75257732	0.924950159	0.358054847	0.100553638411379	0.615556055523183
2007	3.845360825	0.933987796	0.293934214	0.0916224682777713	0.496245959194955
2008	3.533498759	0.626686138	0.14300261	0.000363752090806524	0.285641467355756
2009	6.72098437	1.359021015	0.405700873	0.158426951552838	0.652974794927287
2010	4.80277284	0.956285843	0.302139811	0.123399238494817	0.480880382906739
2011	6.673076923	1.421489316	0.544080268	0.246679421676543	0.841481113691902
2012	6.855670103	1.434502784	0.463806671	0.161814393878736	0.765798947153376
2013	6.643321021	1.328184501	0.419966683	0.0483476411734473	0.791585725663408
2014	5.795287187	1.609628662	0.629324963	0.24418245634209	1.01446746967077
2015	7.131007137	1.654251887	0.564607541	0.264028564632995	0.865186517221544
2016	9.475701487	1.94611284	0.582808716	0.207020438084674	0.958596993974756
2017	11.76701031	2.161968681	0.552997854	0.244861583689981	0.861134124349811
2018	7.046491369	1.601816723	0.555855746	0.2191214703661	0.892590022338879
2019	8.893993725	1.811037126	0.53968153	0.140480417267283	0.938882642973455

Figure 18.1a. Skates and rays in the Celtic Seas. Total landings (tonnes) of skates (Rajidae) in the Celtic Seas (ICES subareas 6–7 including 7.d), from 1903–2015 (Source: Official nominal catches https://www.ices.dk/data/dataset-collections/Pages/Fish-catch-and-stock-assessment.aspx).

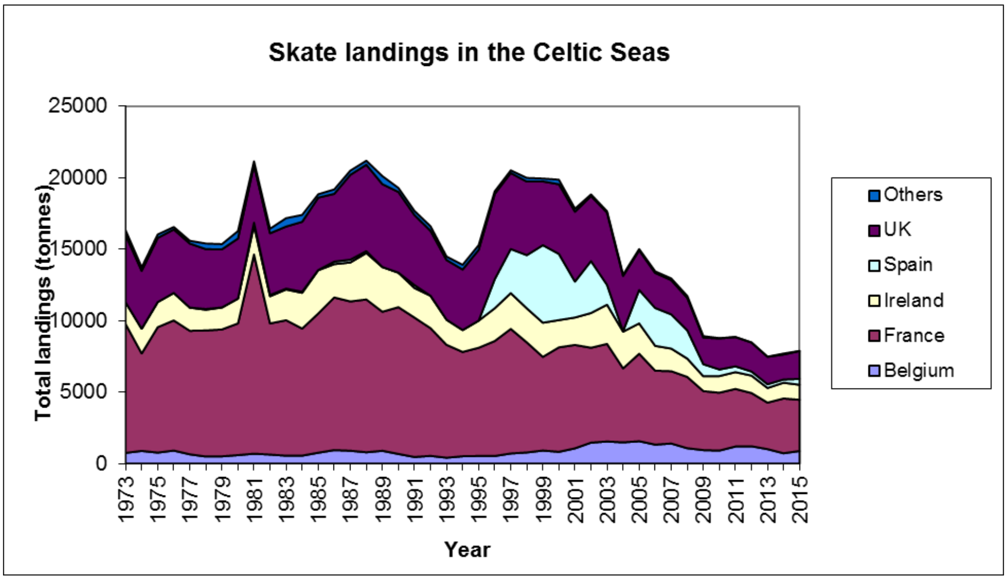


Figure 18.1b. Skates and rays in the Celtic Seas. Total landings (tonnes) of skates (Rajidae) by nation in the Celtic Seas from 1973–2015 (Source: Official nominal catches https://www.ices.dk/data/dataset-collections/Pages/Fish-catch-and-stock-assessment.aspx).

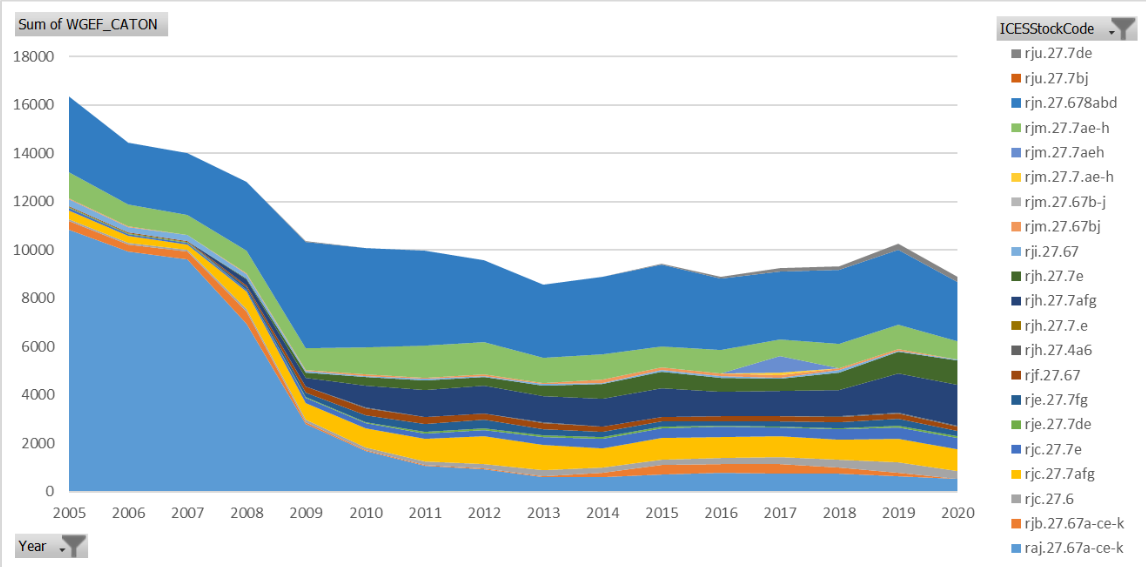


Figure 18.1.c Skates and rays in the Celtic Seas. Total landings (tonnes) of skates (Rajidae) by stock in the Celtic Seas from 2005–2020 (Source: ICES).

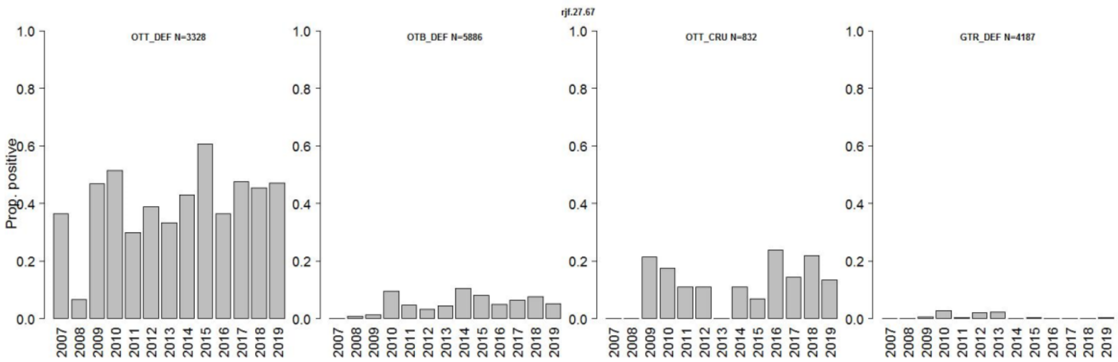


Figure 18.2 Skates and rays in the Celtic Seas. Temporal trends in the proportion of hauls encountering RJF.27.67, based on French on-board observer trips carried out in application of EU data collection programmes.

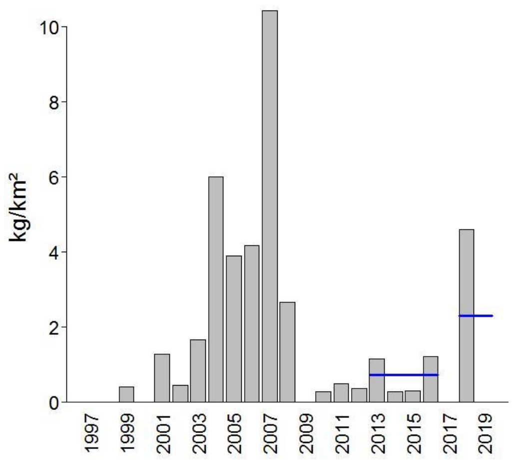


Figure 18.3a. Exploitable biomass (individuals >= 50 cm) per km² of *Leucoraja circularis* in Subarea 7 (stock rji.27.67) from the FR-EVHOE survey (1997–2019, no survey in 2017). Blue lines indicate mean annual biomass for 2018–2019 and for 2013–2016.

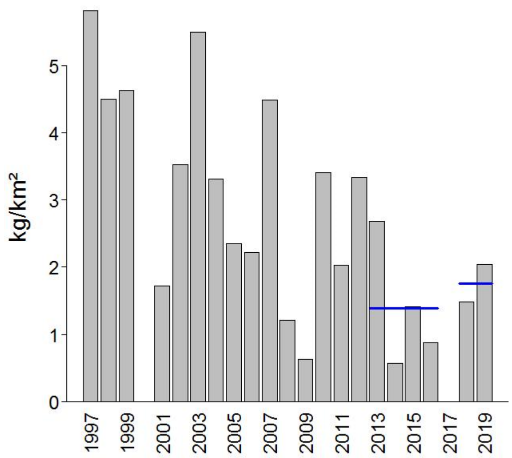


Figure 18.3b. Exploitable biomass (individuals >= 50 cm) per km² of *Leucoraja fullonica* in Subarea 7 (stock rjf.27.67) from the FR-EVHOE survey (1997–2019, no survey in 2017). Blue lines indicate mean annual biomass for 2018–2019 and for 2013–2016.

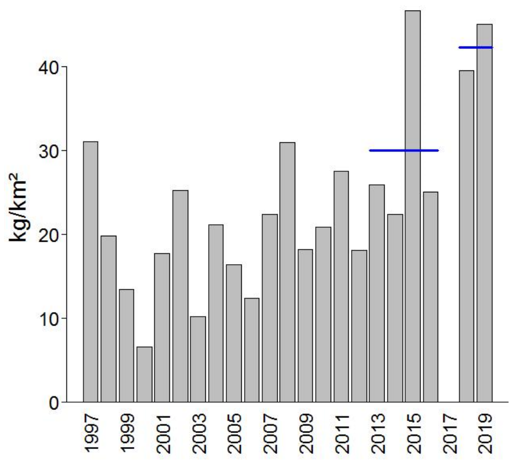


Figure 18.3c. Skates and rays in the Celtic Seas. Exploitable biomass (individuals >= 50 cm) per km² of *Leucoraja naevus* in subareas 6 and 7 from the FR-EVHOE survey (1997–2019, no survey in 2017). Blue lines indicate mean annual biomass for 2018–2019 and for 2013–2016.

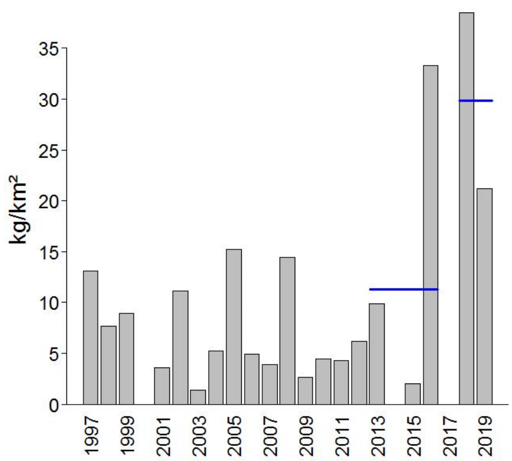


Figure 18.3d. Skates and rays in the Celtic Seas. Exploitable biomass (individuals >= 50 cm) per km² of *Raja clavata* in areas of the stock rjc.27.7afg covered by the FR-EVHOE survey (1997–2019, no survey in 2017). Blue lines indicate mean annual biomass for 2018–2019 and for 2013–2016.

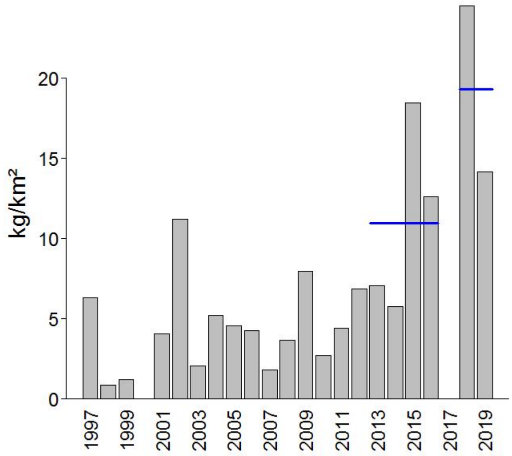


Figure 18.3e. Skates and rays in the Celtic Seas. Exploitable biomass (individuals >= 50 cm) per km² of *Raja montagui* in Subareas 7 (stock rjc.27.7ae-h) from the FR-EVHOE survey (1997–2019, no survey in 2017). Blue lines indicate mean annual biomass for 2018–2019 and for 2013–2016.

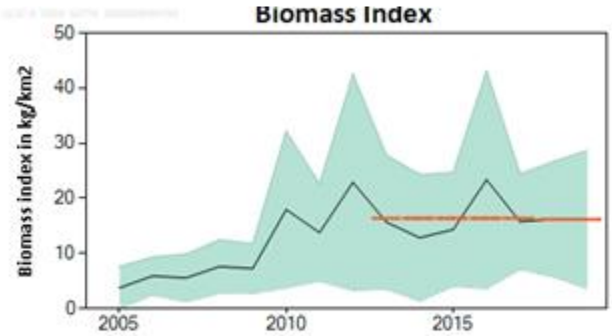


Figure 18.4a. Skates and rays in the Celtic Seas. Irish Groundfish Survey (IGFS-WIBTS-Q4) biomass index of *Raja clavata* in Division 6.a for 2005–2015. Red lines give average for 2013–2017 and for 2018–2019.

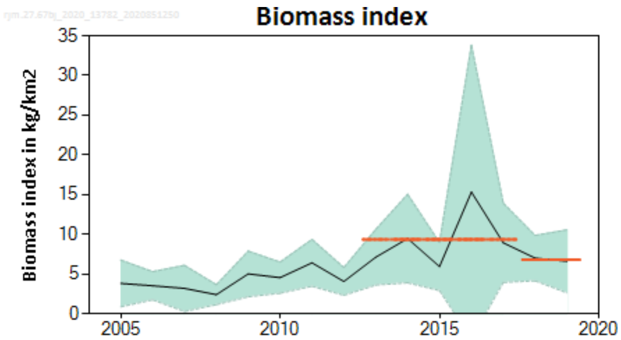


Figure 18.4b. Skates and rays in the Celtic Seas. Irish Groundfish Survey (IGFS-WIBTS-Q4) mean CPUE of *Raja montagui* in Divisions 6.a and 7.b-c for 2005–2019. Red lines give average for 2013–2017 and for 2018–2019.

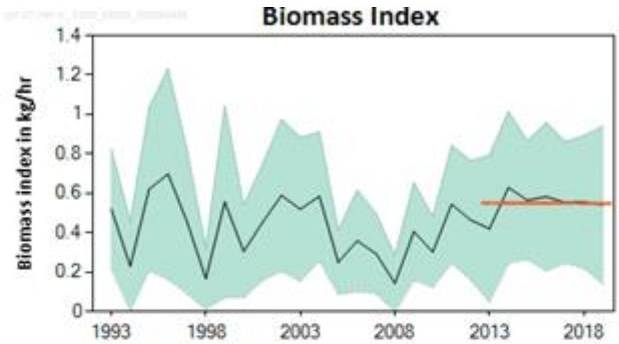


Figure 18.4c. Skates and rays in the Celtic Seas. UK (England and Wales) Irish Sea and Bristol Channel beam trawl survey (EngW-BTS-Q3) mean CPUE of *Raja montagui* in Divisions 7.a, e-h for 1993–2019. Red lines give average for 2013–2017 and for 2018–2019.

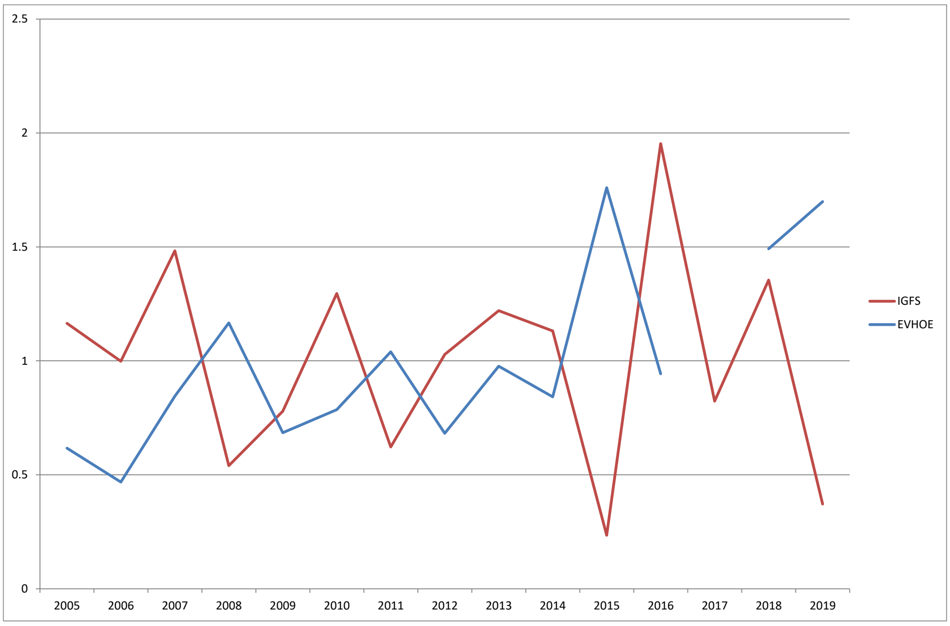
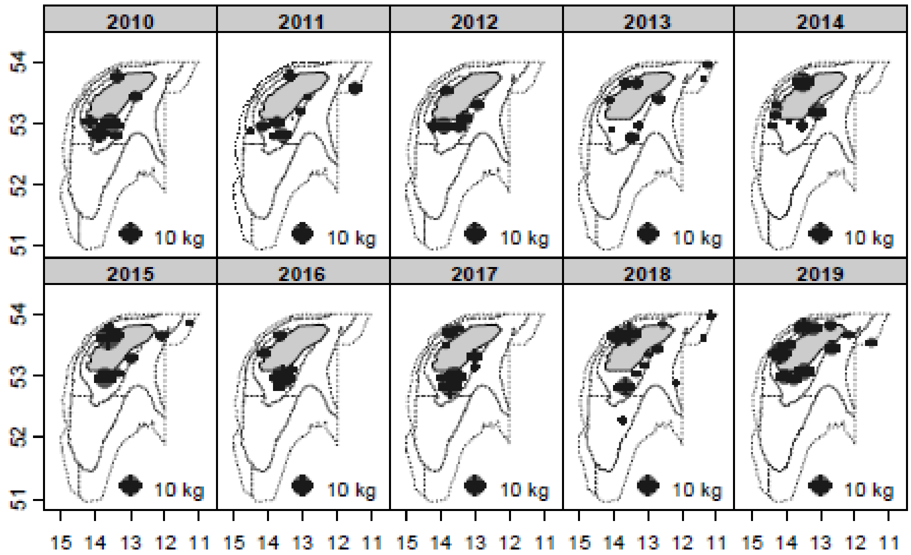


Figure 18.4d. Skates and rays in the Celtic Seas. Irish Groundfish Survey (IGFS-WIBTS-Q4) (red) and French EVHOE survey (blue) standardized biomasses for of *Leucoraja naevu*s in divisions 6, 7, 8.abd. 2005–2019. The French survey did not take place in 2017.



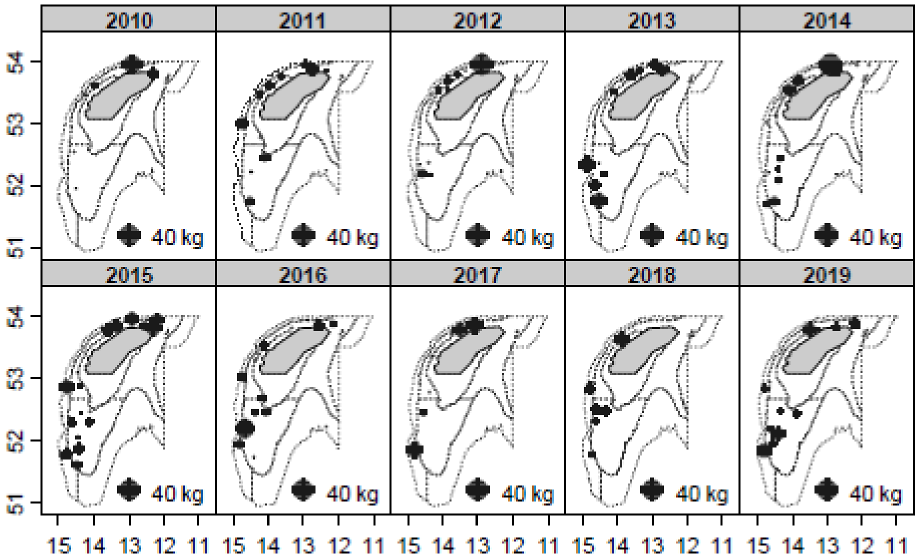


Figure 18.5a. Skates and rays in the Celtic Seas. Geographical distribution of cuckoo ray *Leucoraja naevus* (top) and sandy ray *Leucoraja circularis* (bottom) catches (kg haul^{-1}) in Porcupine survey time-series (2009–2019) (WD02 - Ruiz-Pico *et al.*, 2020).

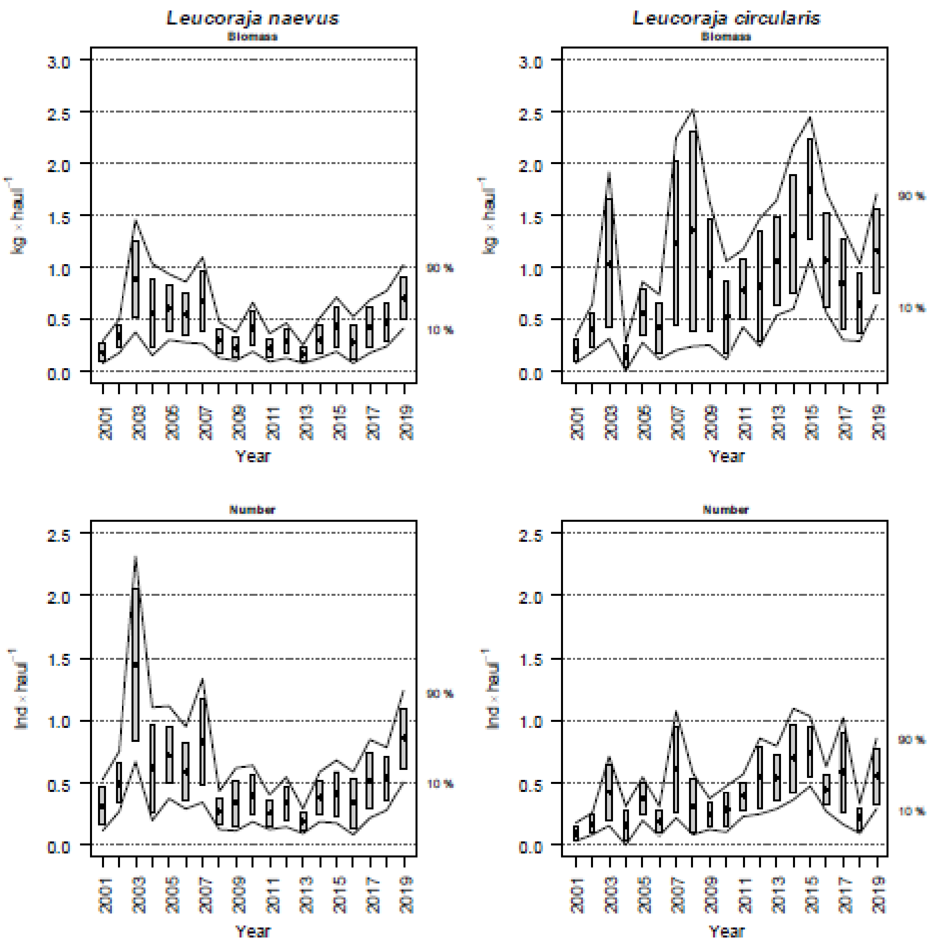


Figure 18.5b. Skates and rays in the Celtic Seas. Temporal changes of cuckoo ray *Leucoraja naevus* and sandy ray *Leucoraja circularis* biomass index (kg haul^{-1}) during Porcupine survey time-series (2001–2019). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000) (WD02 - Ruiz-Pico *et al.*, 2020).

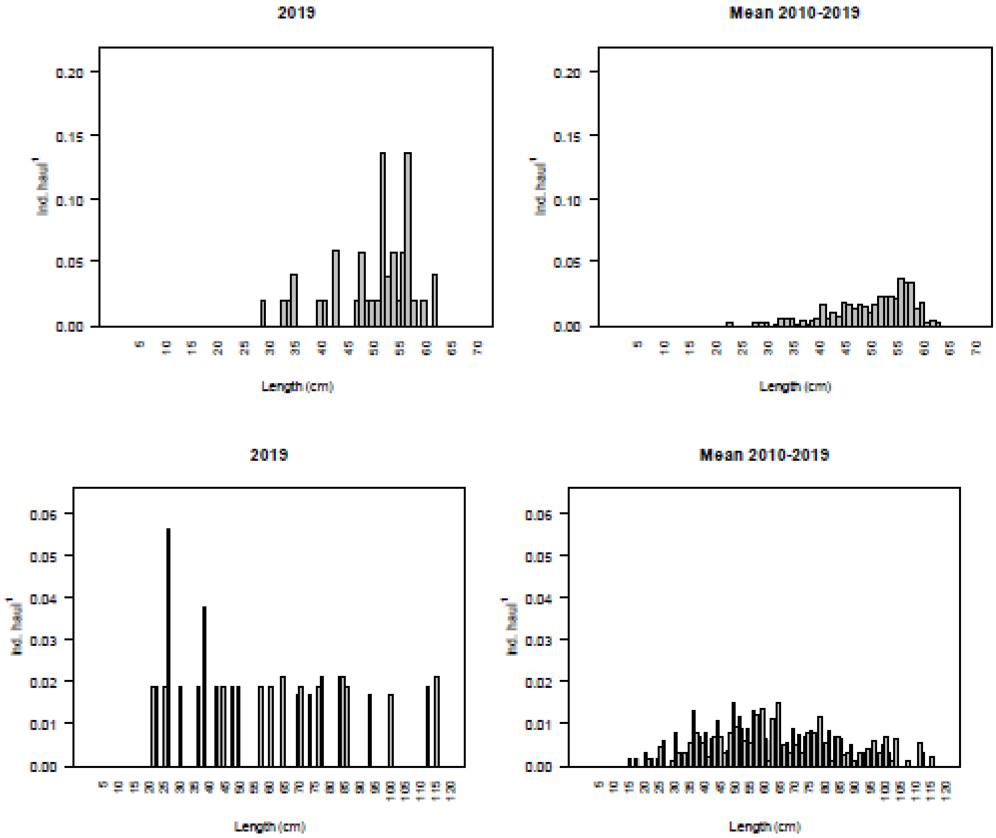


Figure 18.5c. Skates and rays in the Celtic Seas. Stratified length distributions of cuckoo ray *Leucoraja naevus* (top) and sandy ray *Leucoraja circularis* (bottom) in Porcupine survey 2001–2019 (WD02 - Ruiz-Pico *et al.*, 2020).

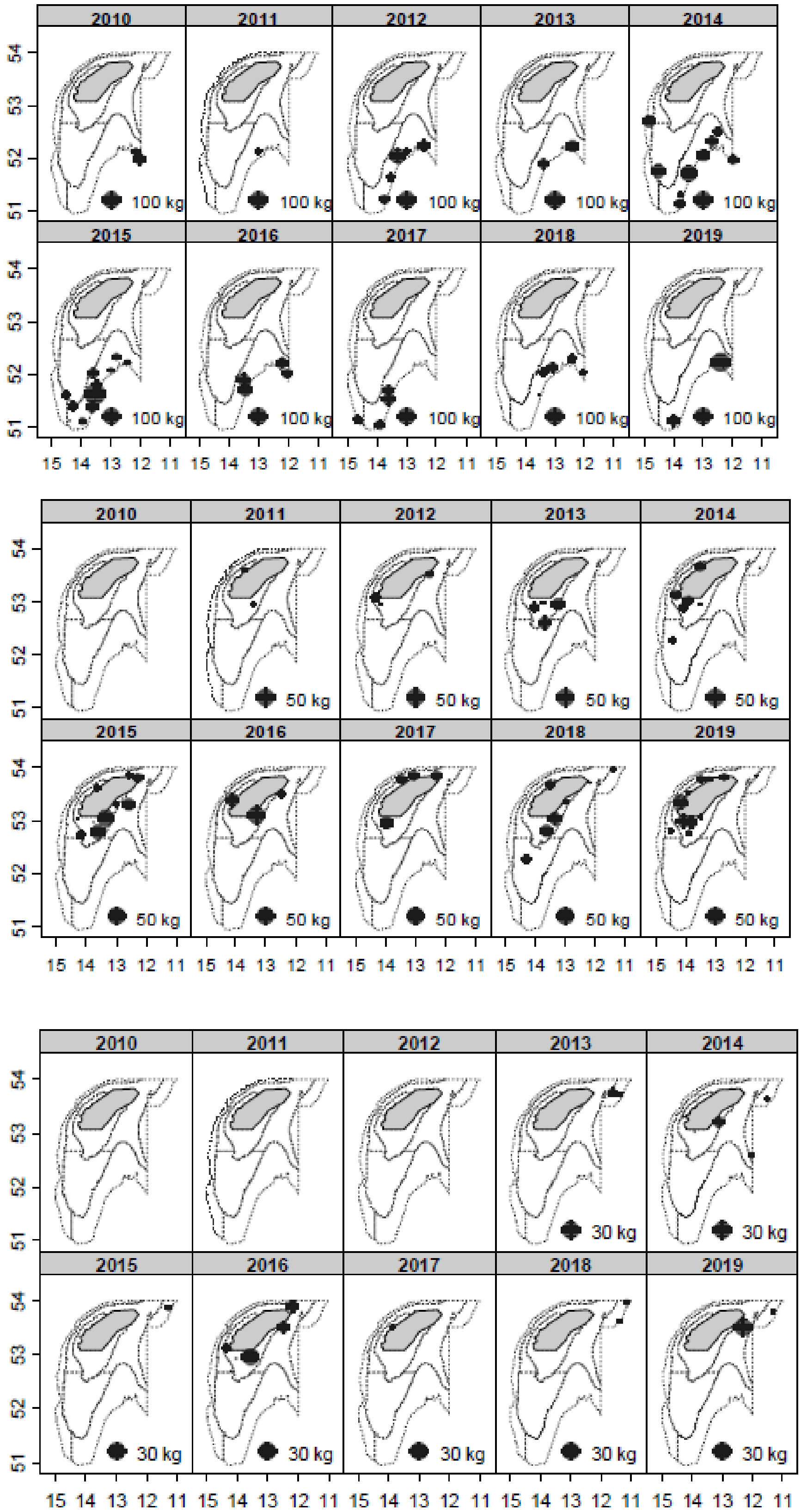


Figure 18.5d. Skates and rays in the Celtic Seas. Geographical distribution of *Dipturus nidarosiensis* (top), *D. batis* (middle) and *D. intermedius* (bottom) (kg haul^{-1}) in Porcupine survey time-series (2008–2019) (WD02 - Ruiz-Pico *et al.*, 2020).

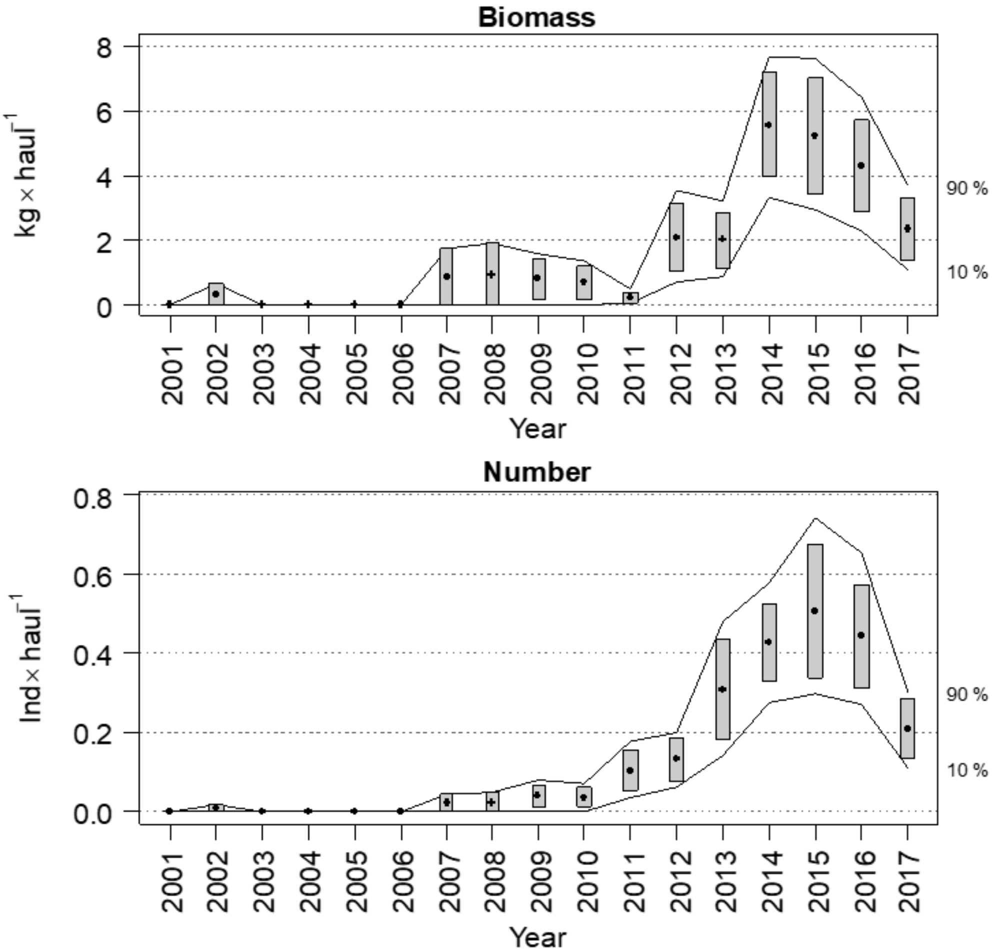


Figure 18.5f. Skates and rays in the Celtic Seas. Changes in *Dipturus* spp. biomass index (kg·haul^{-1}) during Porcupine survey time-series (2001–2017). Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000) (WD02 - Ruiz-Pico *et al.*, 2020).

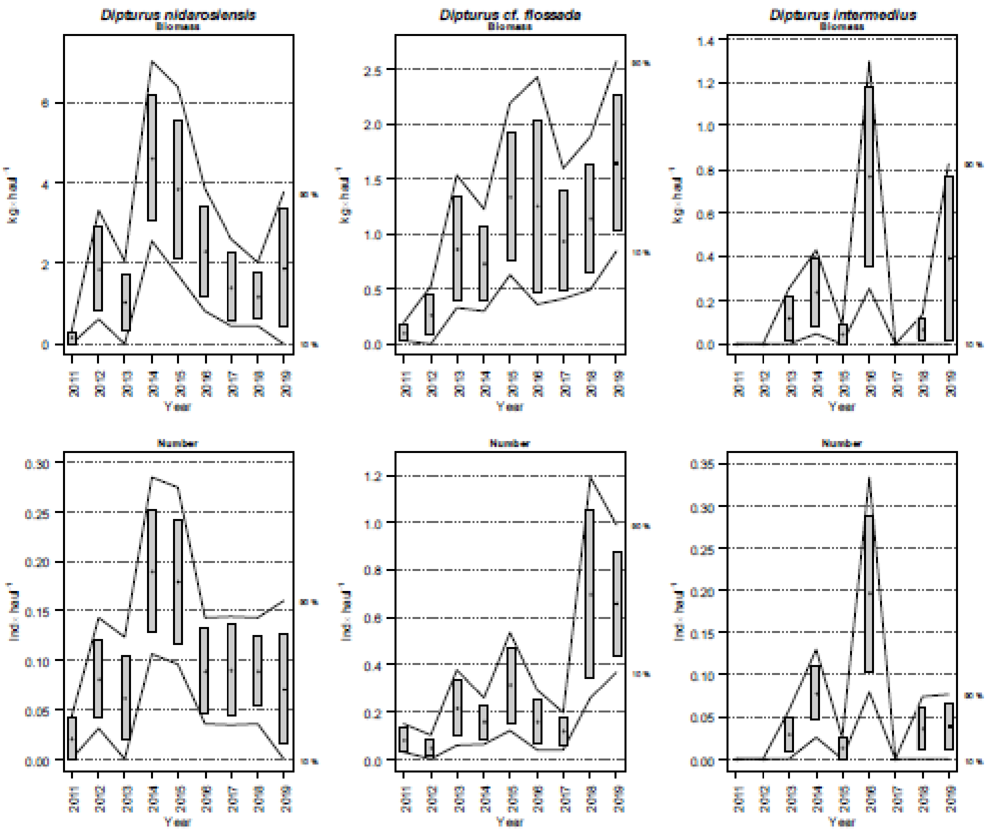


Figure 18.5g. Skates and rays in the Celtic Seas. Changes in *Dipturus nidarosiensis*, *Dipturus batis* (labelled *Dipturus* cf. *flossada*) and *Dipturus intermedius* (labelled *Dipturus* cf. *intermedia*) biomass index (kg haul^{-1}) during Porcupine survey time-series (2011–2019). Boxes mark parametric standard error of the stratified index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000) (WD02 - Ruiz-Pico *et al.*, 2020).

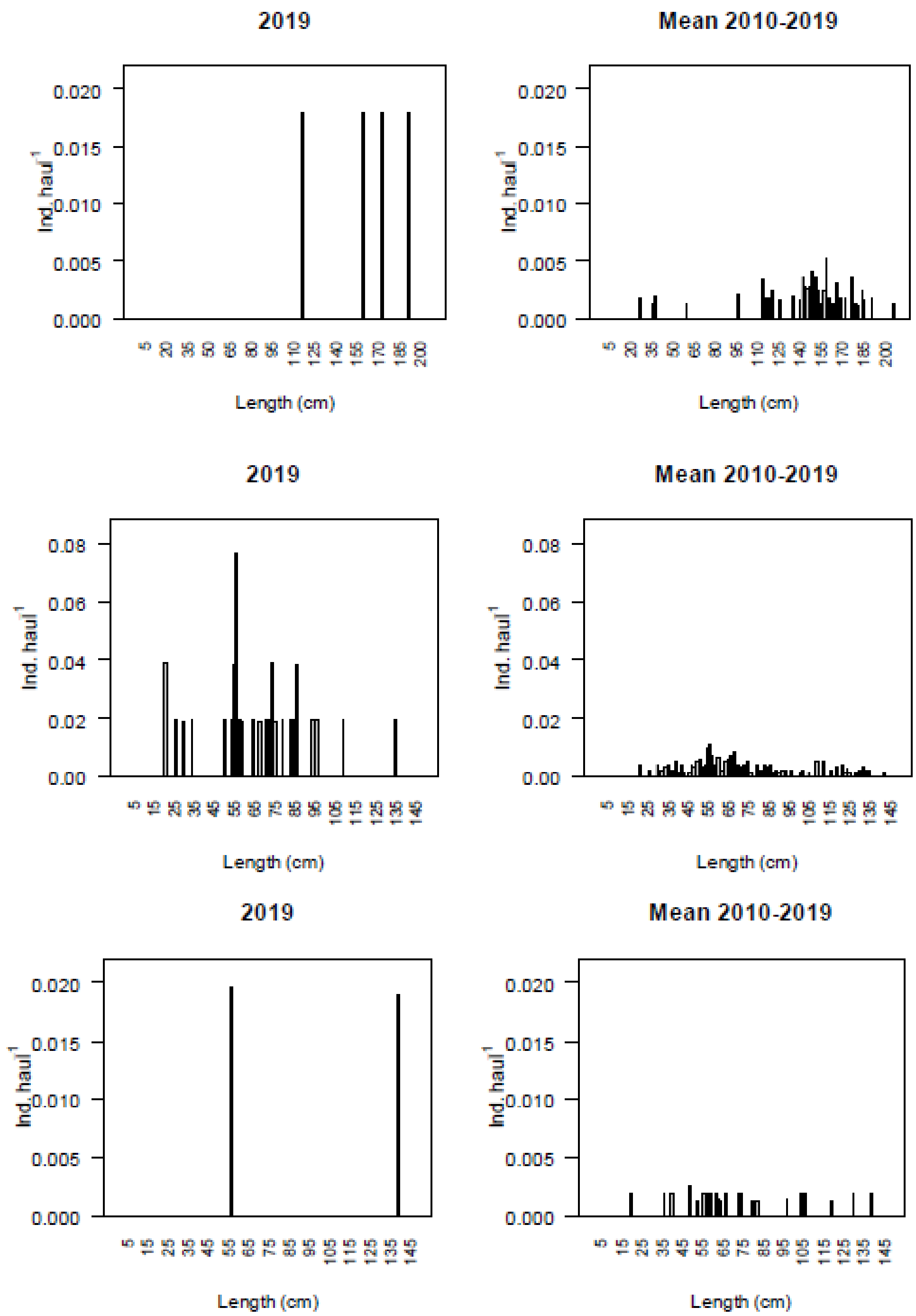


Figure 18.5h. Skates and rays in the Celtic Seas. Mean stratified length distributions of *Dipturus nidarosiensis* (top) and *Dipturus batis (*middle) and *D. intermedius* (bottom) from 2019 Porcupine surveys (WD02 - Ruiz-Pico *et al.*, 2020).

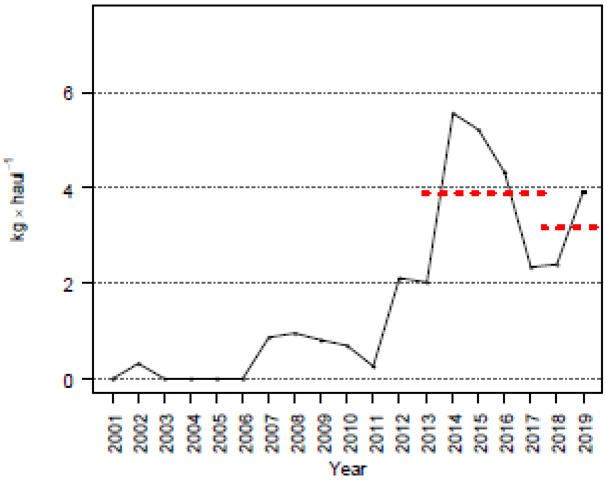


Figure 18.5i. Skates and rays in the Celtic Seas. Changes in *Dipturus* spp. biomass index during Porcupine survey time series (2001–2019). Dotted lines compare mean stratified biomass in the last two years and in the five previous years. (WD02 - Ruiz-Pico *et al.*, 2020).

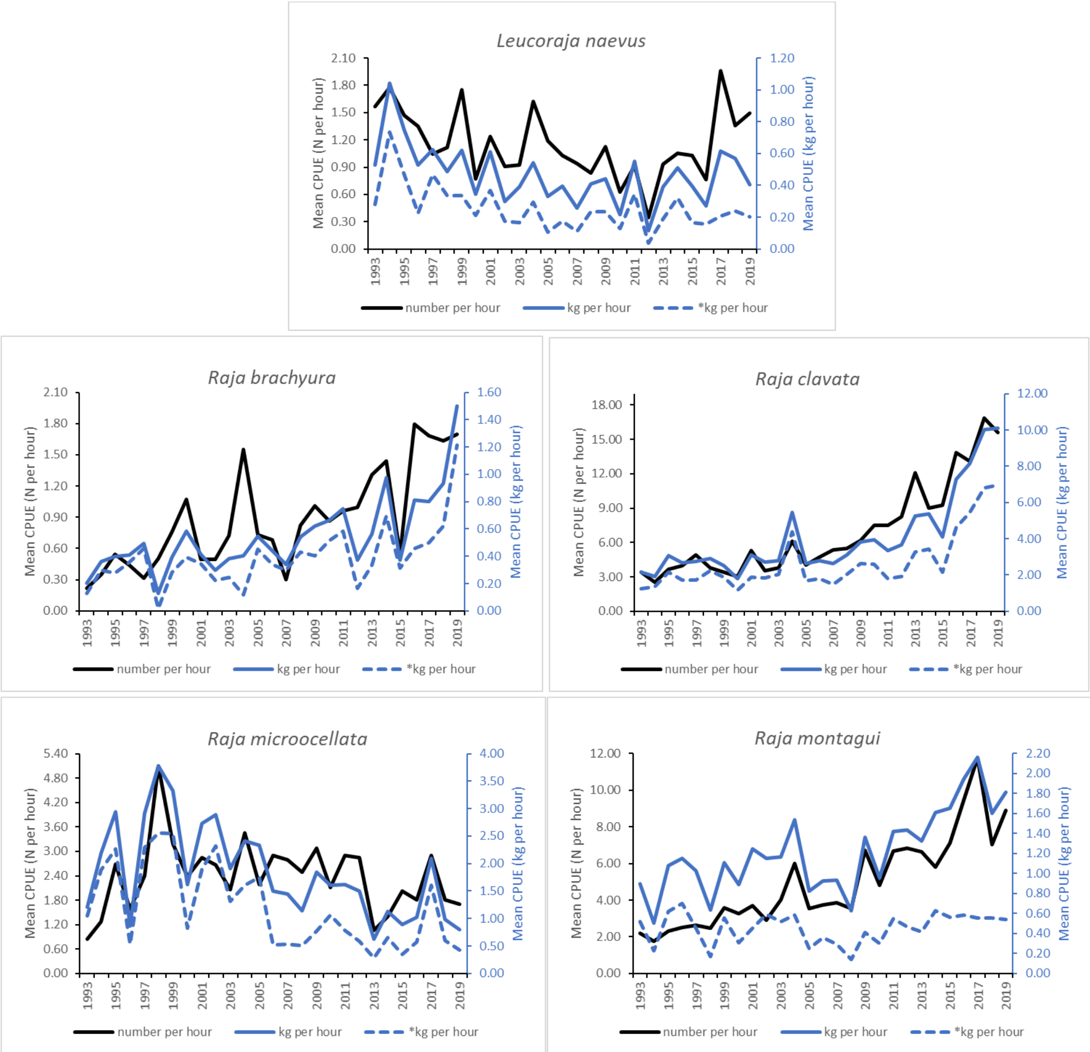


Figure 18.6. Skates and rays in the Celtic Seas. Temporal trends (1993–2019) in the CPUE by individuals (n.h^{-1}; solid black line), biomass (kg h^{-1}; solid blue line), and biomass for individuals ≥50 cm total length (kg h^{-1}; dashed blue line) of skates in the 7.a.f–g beam trawl survey (EngW-BTS-Q3; Source: WD04 - Silva and Ellis, 2020).

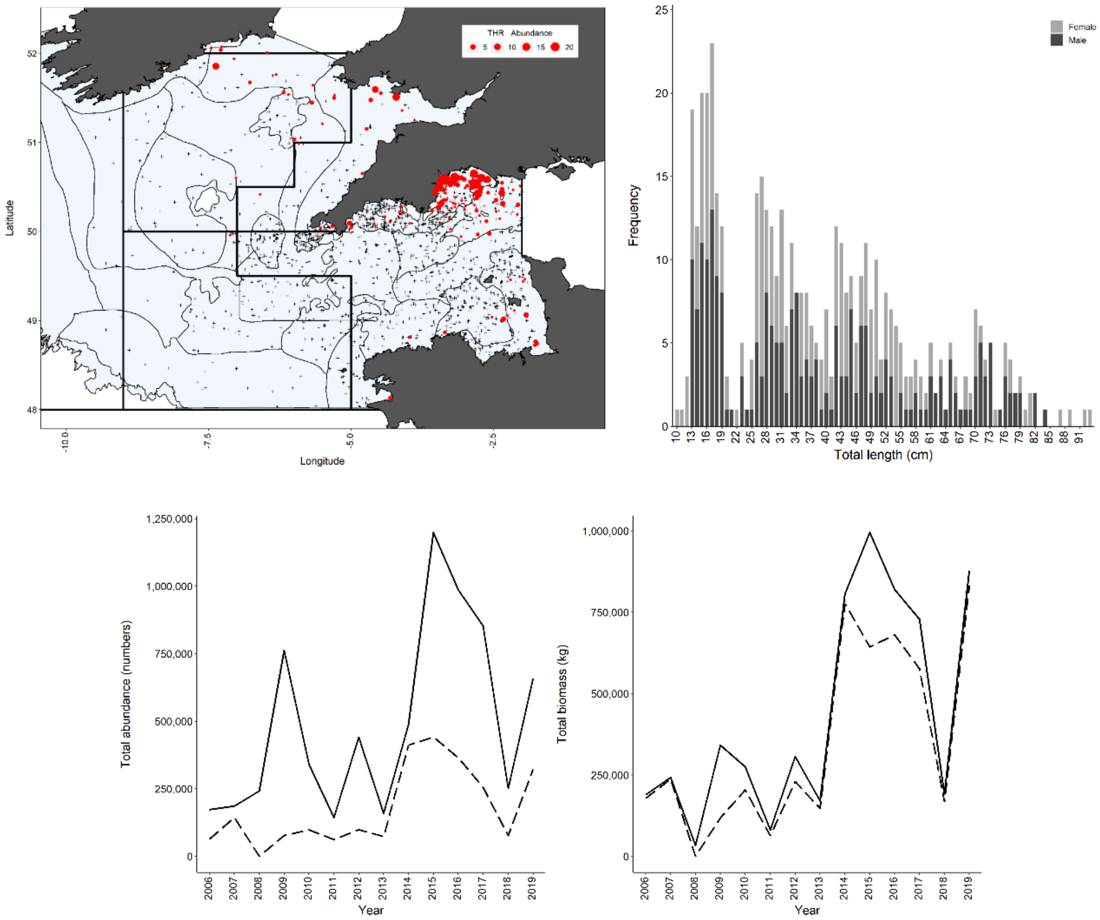


Figure 18.7a. Skates in the Celtic Sea. Distribution and relative abundance (top left) and length-frequency by sex (top right) of thornback ray *Raja clavata* in the Q1SWECOS trawl survey. Preliminary estimates of total abundance (numbers) and biomass (kg) - continuous line relates to all specimens, dashed line relates to individuals ≥50 cm total length. (Source: WD05 - Silva *et al.,* 2020)

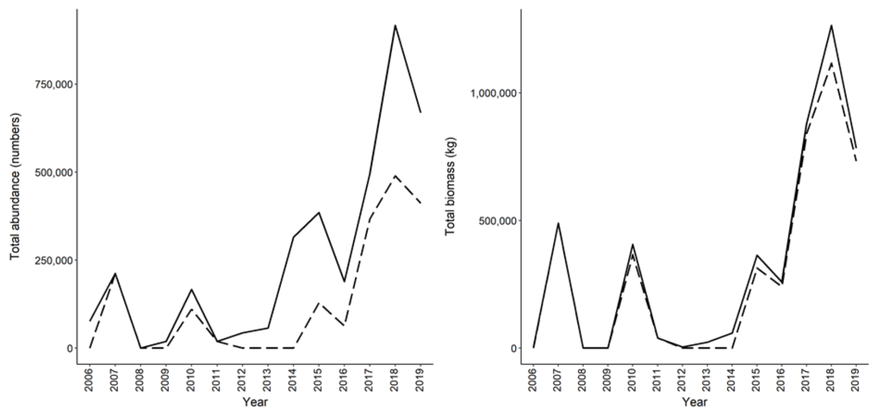


Figure 18.7b. Skates in the Celtic Sea. Demersal elasmobranchs in the Q1SWECOS indicating preliminary estimates of total abundance (numbers) and total biomass (kg) for common skate *Dipturus batis*-complex. Continuous line relates to all specimens, dashed line relates to individuals ≥50 cm total length. (Source: WD05 - Silva *et al.,* 2020).

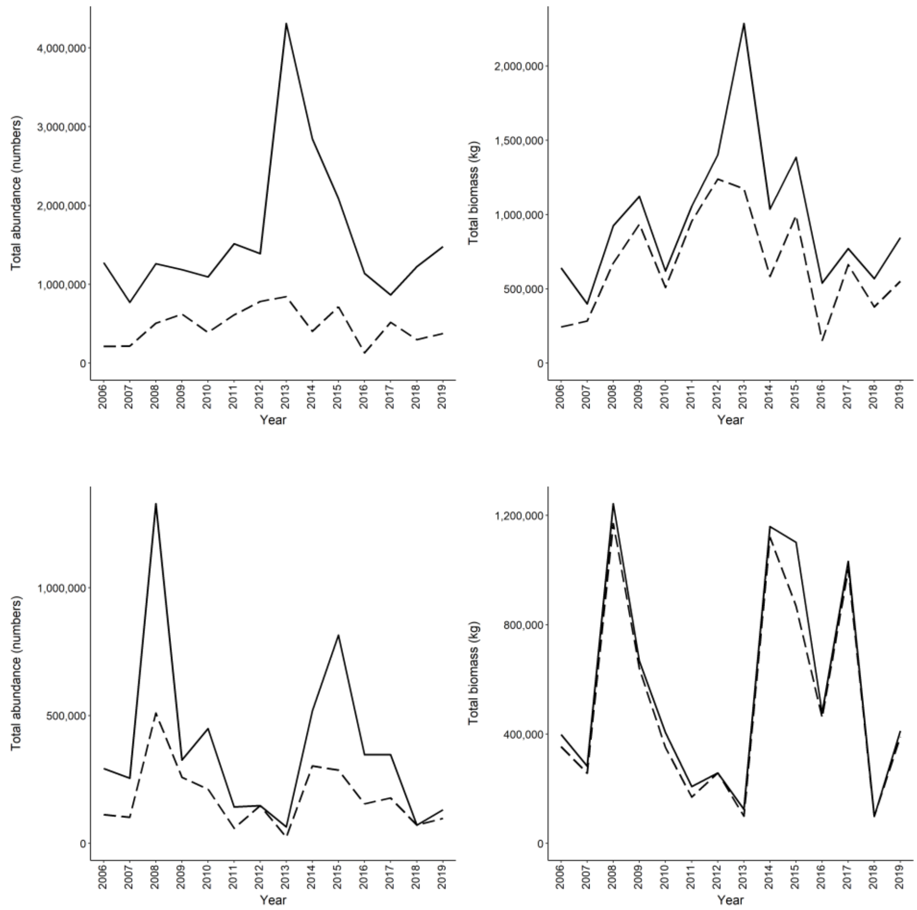


Figure 18.7c. Skates in the Celtic Sea. Demersal elasmobranchs in the Q1SWECOS indicating preliminary estimates of total abundance (numbers) and total biomass (kg) for (top) cuckoo ray *Leucoraja naevus* and (bottom) blonde ray *Raja brachyura*. Continuous line relates to all specimens, dashed line relates to individuals ≥50 cm total length. (Source: WD05 - Silva *et al.,* 2020).

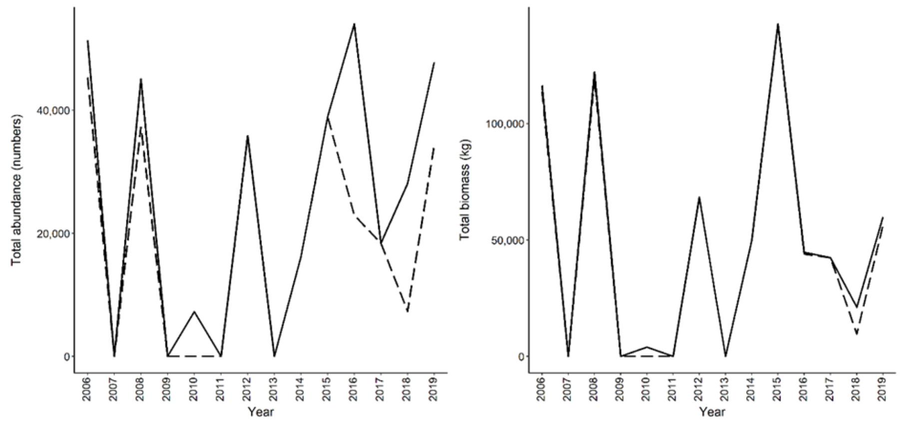


Figure 18.7d. Skates in the Celtic Sea. Demersal elasmobranchs in the Q1SWECOS indicating preliminary estimates of total abundance (numbers) and total biomass (kg) for small-eyed ray *Raja microocellata*. Continuous line relates to all specimens, dashed line relates to individuals ≥50 cm total length. (Source: WD05 - Silva *et al.,* 2020).

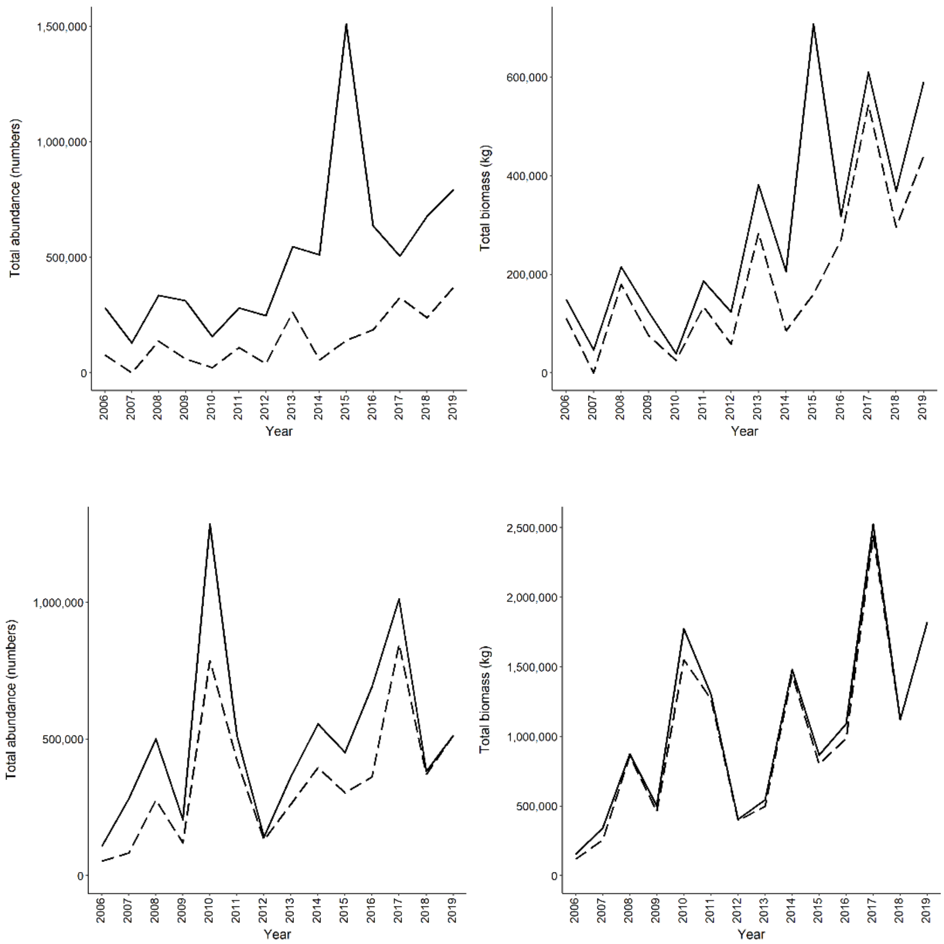


Figure 18.7e. Skates in the Celtic Sea. Demersal elasmobranchs in the Q1SWECOS indicating preliminary estimates of total abundance (numbers) and total biomass (kg) for (top) spotted ray *Raja montagui* and (bottom) undulate ray *Raja undulata*. Continuous line relates to all specimens, dashed line relates to individuals ≥50 cm total length. (Source: WD05 - Silva *et al.,* 2020)

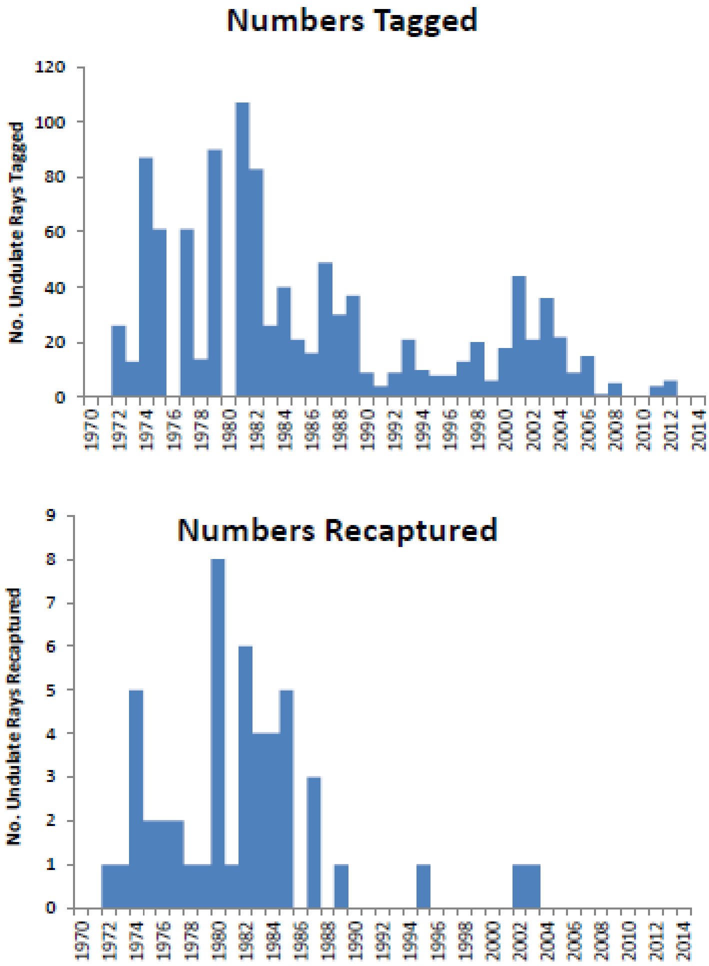


Figure 18.8. Skates in the Celtic Seas. Numbers of *Raja undulata* tagged (top) and recaptured (bottom) in Tralee Bay and surroundings, 1970–2014. Source: Wögerbauer *et al.*, 2014 WD.

19 Skates in the Bay of Biscay and Iberian Waters (ICES Subarea 8 and Division 9.a)

ICES uses the generic term “skate” to refer to all members of the order Rajiformes. The generic term “ray”, formerly used by ICES also to refer to Rajiformes, is now only used to refer to other batoid fish, including manta rays and sting rays (Myliobatiformes), and electric rays (Torpediniformes). ICES only provides routine advice for Rajiformes.

19.1 Ecoregion and stock boundaries

The Bay of Biscay and Iberian Waters ecoregion covers the Bay of Biscay (divisions 8.a-b and 8.d), including the Cantabrian Sea (Division 8.c), and the Spanish and Portuguese Atlantic coast (Division 9.a). This ecoregion broadly equates with the area covered by the South Western Waters Advisory Council (SWWAC). Commercially-exploited skates do not occur in the offshore Division 8.e to any significant extent.

The northern part of the Bay of Biscay has a wide continental shelf with flat and soft bottom more suitable for trawlers, whilst the Cantabrian Sea has a narrower continental shelf with some remarkable bathymetric features (canyons, marginal shelves, etc.). The Portuguese continental shelf (Division 9.a) is narrow, except for the area located between the Minho River and the Nazaré Canyon, and in the Gulf of Cadíz, where it is about 50 km wide, particularly to the east. The slope is mainly steep with a rough bottom including canyons and cliffs.

Rajidae are widespread throughout this ecoregion but there are regional differences in their distribution as described in earlier reports (ICES, 2010), and this is particularly evident for those species with patchier distributions and limited dispersal (Carrier *et al*., 2004).

Skates in this ecoregion include thornback ray *Raja clavata*, cuckoo ray *Leucoraja naevus*, the less frequent blonde ray *Raja brachyura*, small-eyed ray *R. microocellata*, brown ray *R. miraletus*, spotted ray *R. montagui*, undulate ray *R. undulata*, shagreen ray *Leucoraja fullonica*, common skate *Dipturus batis*-complex, (recently split into *D. batis* and *D. intermedius*), long-nosed skate *D. oxyrinchus*, sandy ray *Leucoraja circularis* and white skate *Rostroraja alba*.

Studies undertaken in the centre of Portugal (Division 9.a; Serra-Pereira *et al*., 2014), and in the Cantabrian Sea (eastern parts of Division 8.c) indicate spatial overlap between *R. clavata* and *L. naevus* (e.g. Sánchez, 1993). In the Bay of Biscay, *L. naevus* is more abundant on the offshore trawling grounds (Sánchez *et al*., 2002). Along the Portuguese coast *R. clavata* and *L. naevus* co-occur in areas deeper than 100 m, on grounds composed of soft bottom, from mud to fine sand (Serra-Pereira *et al*., 2014). *Raja clavata* can also be found from rocky to coarse sandy bottoms. *Raja brachyura* occurs primarily near the coast in shallower depths in areas of rocks surrounded by sand. Juvenile *R. brachyura*, *R. montagui* and *R. clavata* co-occur on grounds shallower than 100 m. In this ecoregion, *R. undulata* and *R. microocellata* occur at depths < 40 m over sandy bottoms. *R. undulata* is locally common in the shallow waters between the Loire and Gironde estuaries (eastern Bay of Biscay; divisions 8.a-b) and occurs along most of the French coastal.

The geographical distributions of the main skate species in the ecoregion are known, but their stock structure still needs to be more accurately defined. Studies (e.g. tagging and/or genetic studies) to better understand stock structure are required.

A tagging survey of *R. undulata* carried out in the Bay of Biscay (2012–2013) showed that movements of this species were limited to *ca.* 30 km (Delamare *et al*., 2013 WD; Biais *et al*., 2014 WD).

This result supports the hypothesis that several local stocks exist in European waters and corroborates the assumption of three distinct assessment units (divisions 8.a–b; 8.c and 9.a) in this ecoregion.

For most other skate species, WGEF considers two management units in this ecoregion: Subarea 8 (Bay of Biscay) and Division 9.a (Iberian waters). Since 2015, the cuckoo ray from ICES subareas 6 and 7 in the Celtic seas ecoregion and the Bay of Biscay is considered to form one single stock, cuckoo ray in subareas 6 and 7 and divisions 8.a-b,d. In addition, there are two stocks of cuckoo ray in this ecoregion: in Division 8.c (Cantabrian Sea) and Division 9.a (Iberian waters).

19.2 The fishery

19.2.1 History of the fishery

In the Bay of Biscay and Iberian waters, skates are caught mainly as a bycatch in mixed demersal fisheries, which target either flatfish (including sole) or gadiforms (e.g. hake). The main fishing gears used are otter trawl, bottom-set gillnets and trammel nets. The countries involved in these fisheries are France, Spain and Portugal, as detailed below.

France

Skates are traditional food resources in France, where target fisheries were known to occur during the 1800s. In the 1960s, skates were taken primarily as a bycatch of bottom trawl fisheries operating in the northern parts of the Bay of Biscay, the southern Celtic Sea and English Channel. By this time, *R. clavata* was targeted seasonally by some fisheries, and was the dominant skate species landed. After the 1980s, *L. naevus* became the main species landed. However, landings of both *R. clavata* and *L. naevus* declined after 1986.

Other skates are also landed, including *L. circularis*, *L. fullonica*, *R. microocellata, D. batis* complex (mostly blue skate), which is included in prohibited species by the EU regulation since 2010, and *D. oxyrinchus*. There have been no major annual landings of *Rostroraja alba* by French fleets in the past three decades.

The historical French catches of skates in coastal fisheries are poorly known. Most landings of skates and rays were not reported by species before 2009 where species-specific reporting of landings was required by the EU regulation. For *Raja undulata,* this imply that no species-specific landings were reported before its inclusion on the EU prohibited species list and past levels of catch are unknown.

Spain

Spanish demersal fisheries operating in the Cantabrian Sea (Division 8.c) and Bay of Biscay (divisions 8.a-b and 8.d) catch various skate species using different fishing gears. Most landings are a bycatch from trawl fisheries targeting demersal teleosts, (e.g. hake, anglerfish and megrim). Among the skate species landed, *L. naevus* and *R. clavata* are the most frequent. Historically, due to their low commercial value, most skate species, especially those derived from artisanal gillnetters, were reported as Rajidae. There are artisanal gillnet fisheries operating in bays, rias and shallow waters along the Cantabrian Sea and Galician coasts (divisions 8.c and 9.a). *R. undulata* is caught mainly in the coastal waters of Galicia (northern part of Division 9.a and western part of Division 8.c) where it was frequently landed and one of the most abundant species inside the rias. Other skate species caught in Galician waters include *R. brachyura*, *R. microocellata*, R. *montagui*, *R. clavata* and *L. naevus*. The characteristics of Spanish artisanal fleets catching skates are not fully known.

Mainland Portugal

Off mainland Portugal (Division 9.a), skates are caught mainly by the artisanal polyvalent fleet with a smaller contribution of trawlers to landings. The artisanal fleet operates mostly with trammel nets, but other fishing gears (e.g. longlines and gillnets) are also used. The skate species composition of landings varies along the Portuguese coast. *R. clavata* is the main species landed, but *R. brachyura*, *L. naevus* and *R. montagui* are also caught. Before being prohibited, *R. undulata* was frequently landed, particularly at the northern landing ports. Other species, such as *R. microocellata*, *D. oxyrinchus*, *R. miraletus*, *R. alba* and *L. circularis,* are also caught, albeit less frequently (particularly the latter three species). Further details on fisheries in Division 9.a are given in Stock Annexes.

19.2.2 The fishery in 2020

COVID-19 is expected to have affected fishing activity in 2020, although so far unquantified, with national or local restrictions on fishing activity reducing fishing effort for at least part of the year.

Apart from COVID-19, no other clear changes are noted for 2020, with descriptions of recent investigations provided below.

France

Landings and on-board observation data confirm that skates are primarily a bycatch in numerous fisheries operating in the Bay of Biscay. French landings statistics from more than 100 métiers (defined at DCF level 6) report landings of *R. clavata* and *R. montagui* in the Bay of Biscay. Trammel nets are the main métier for *R. montagui*, while twin-trawl is the main métier for *R. clavata*.

Spain

The results from the DCF pilot study held from 2011–2013 and conducted in the Basque Country waters (Division 8.c) with the objective of describing and characterizing coastal artisanal fisheries (trammel nets targeting mainly hake, anglerfish and mackerel), showed that several skate species (*R. clavata*, *R. montagui*, *L. naevus*, *L. fullonica, L. circularis, R. brachyura* and *R. undulata*) are caught as bycatch. The Basque artisanal fleet consists of 55 small vessels that use gillnets and trammel nets during some periods of the year. Vessels have an average length of 12.7 m and an average engine power of 82.4 kW. The proportions of skates in the total sampled trips were 30% (2011), 35% (2012) and 16% (2013). The estimated landings of skates by this fleet were 19.3 t in 2012 and 26.9 t in 2013 (Diez *et al.*, 2014 WD).

In the Cantabrian Sea (Division 8.c) most skate landings are also from bycatch from otter trawl (47%) and gillnet gears (43%). The remaining landings are derived from longlines and other fishing gears.

Mainland Portugal

Skates are mainly a bycatch in mixed fisheries, particularly from the artisanal polyvalent fleet (representing around 80% of landings). Set nets (mainly trammel nets), or a combination of set nets and traps, account for most skates' landings (*ca.* 72% in weight and 78% in number of trips in 2020), followed by longline (*ca.* 11% in weight and 11% in number of trips in 2020). Also, within the artisanal polyvalent fleet, small trawlers may account for 5% in weight and 6% in number of trips of the total landings of skates and rays, being only observed in certain landing ports. Methods to estimates landings by skate species were developed during the DCF-funded pilot study focused on skate catches in Portuguese continental fisheries carried out from 2011 to 2013 (Maia *et al.*, 2013 WD).

The experimental quota of *R. undulata* assigned to Portugal since 2016 requires a special fishing license for this species. Vessels, with the license are mainly operating close to the coast. This fishery is TAC constrained and has as the main goal to provide fishery data for future scientific advice.

19.2.3 ICES Advice applicable

Before 2012, ICES provided general advice on skates, but this is inadequate as skate species have different life-history traits. Also, a generic skate TAC does not take into account that several stocks straddle the boundary with other management areas. For instance, *L. naevus* is a stock straddling subareas 6 and 7 (excl. Division 7.d) and divisions 8.a-b and 8.d.

From 2012–2014, ICES has moved towards providing advice at the individual stock level, giving quantitative advice where possible.

Advice on skates is given biannually and the last advice provided for Bay of Biscay and Iberian Waters ecoregion was given in 2020 (for 2021 and 2022). For most stocks a landings advice was given, a summary of these and details for stock not subject to a landings advice or for which the advice was more complex is summarised in the table below.

It is important to note that this does not sum up to a generic advice for skates in subareas 8 and 9 and should not be interpreted as advice in relation to the generic skate TAC applicable to this management area.

Scientific name	ICES stock code	Management unit	Catches/Landings advice for 2021 and 2022 (tonnes)	Advice basis
Raja undulata	rju.27.8ab	8.a,b	Catches should be no more than 202 tonnes of which no more than 13 tonnes should be landed	Catches
Raja undulata	rju.27.8c	8.c	No targeted fisheries, manage bycatch	
Raja clavata	rjc.27.8	8	389	Landings
Leucoraja naevus	rjn.27.8c	8.c	Catches should be no more than 42 tonnes of which no more than 31 tonnes should be landed	Catches
Raja montagui	rjm.27.8	8	129	Landings
Raja montagui	rjm.27.9a	9.a	108	Landings
Leucoraja naevus	rjn.27.9a	9.a	Catches should be no more than 120 tonnes of which no more than 84 tonnes should be landed	Catches
Raja clavata	rjc.27.9a	9.a	1717	Landings
Raja undulata	rju.27.9a	9.a	31	Landings
Raja brachyura	rjh.27.9a	9.a	254	Landings
Dipturus batis complex *(Dipturus batis)* *(Dipturus intermedius)*	rjb.27.89a	8, 9.a	No advice requested	
Other skates	raj.27.89a	8, 9.a	ICES cannot provide catch advice	

19.2.4 Management applicable

An EU TAC for skates (Rajiformes) in subareas 8 and 9 was first established in 2009, and set at 6423 t. Since then, the TAC was reduced by approximately 15% in 2010, 15% in 2011, 9% in 2012, 10% in 2013, 10% in 2014, remained stable in 2015 and 2016, and increased by 9% in 2017, 15% in 2018, 10% in 2019, remained stable in 2020, and increased by 8% in 2021. The history of the EU regulations adopted for skates in this ecoregion and the ICES landings estimates for all Rajiformes (excluding *Raja undulata* from 2014 onwards, where subTACs were set for this species from 2015 in Subarea 8 and from 2016 in Division 9.a) is summarized below:

Year	TAC for EC waters of subareas 8 and 9	ICES landing estimates	Regulation
2009	6423 t	4327 t	Council Regulation (EC) No 43/2009 of 16 January 2009 (1,2)
2010	5459 t	4140 t	Council Regulation (EU) No 23/2010 of 14 January 2010 (1,2)
2011	4640 t	4144 t	Council Regulation (EU) No 57/2011 of 18 January 2011 (1,2)
2012	4222 t	3766 t	Council Regulation (EU) No 43/2012 of 17 January 2012 (1,2)
2013	3800 t	3686 t	Council Regulation (EU) No 39/2013 of 21 January 2013 (3,2)
2014	3420 t	3685 t	Council Regulation (EU) No 43/2014 of 20 January 2014 (3,2)
2015	3420 t	3507 t	Council Regulation (EU) No 104/2015 of 19 January 2015 amended by the Council Regulation (EU) No 523/2015 of 25 March 2015 (3,4)
2016	3420 t	3296 t	Council Regulation (EU) No 72/2016 of 22 January 2016 (3,4)
2017	3762 t	3430 t	Council Regulation (EU) No 2017/127 of 20 January 2017 (3,4)
2018	4314 t	3795 t	Council Regulation (EU) No 2018/120 of 23 January 2018 (3,4)
2019	4759 t	3550 t	Council Regulation (EU) No 2019/124 of 30 January 2019 (3,4)
2020	4759 t	3373 t	Council Regulation (EU) No 2020/123 of 27 January 2020 (3,4)
2021	5129 t	NA	Council Regulation (EU) No 2021/703 of 26 April 2021 (3,4)*

(1) Catches of cuckoo ray (*Leucoraja naevus*) (RJN/89-C), thornback ray (*Raja clavata*) (RJC/89-C) shall be reported separately.

(2) Does not apply to undulate ray (*Raja undulata*), common skate complex (*Dipturus batis* and *D. intermedius*) and white skate (*Rostroraja alba*). Catches of these species may not be retained on board and shall be promptly released unharmed to the extent practicable. Fishers shall be encouraged to develop and use techniques and equipment to facilitate the rapid and safe release of the species.

(3) Catches of cuckoo ray (*Leucoraja naevus*) (RJN/89-C), blonde ray (*Raja brachyura*) (RJH/89-C), and thornback ray (*Raja clavata*) (RJC/89-C) shall be reported separately.

(4) Shall not apply to undulate ray (*Raja undulata*). This species shall not be targeted in the areas covered by this TAC. By-catch of undulate ray in subarea 8 (since 2015) and 9 (since 2016) may only be landed whole or gutted, and provided that it does not comprise more than 20 kilograms live weight per fishing trip in subarea 8 (in 2015 and 2016) and 40 kilograms of live weight per fishing trip in subarea 9 (in 2016). This provision shall not apply for catches subject to the landing obligation. By-catches of undulate ray shall be reported separately under the codes RJU/8-C and RJU/9-C, respectively for each subarea.

*** UK quota not agreed at the time of publication.**

Regarding *R. undulata* no management measures had been adopted by European Commission (EC) until 2009, when EC regulations stated that *Undulate ray … (in) … EC waters of VI, VII, VIII, IX and X … may not be retained on board. Catches of this species shall be promptly released unharmed to the extent practicable* (CEC, 2009). In 2010, *R. undulata* was listed as a prohibited species on quota regulations (Section 6 of CEC, 2010). In 2017, EC stated that *shall be prohibited for third-country vessels to fish for, to retain on board, to tranship or to land the following* undulate ray *whenever they are found in Union waters of ICES subareas VI, IX and X (*Council Regulation (EU) No 2017/127). A bycatch TAC was established for Subarea 8 since 2015 and for Subarea 9 since 2016, under the limits presented in the table below:

Year	TAC for EU waters of Subarea 8	TAC for EU waters of Subarea 9	ICES landing estimates in Subarea 8	ICES landing estimates in Subarea 9	Regulation
2015	25 t	-	16 t	-	Council Regulation (EU) No 523/2015 of 25 March 2015 (3,4)
2016	25 t	40 t	21 t	31 t	Council Regulation (EU) No 72/2016 of 22 January 2016 (3,4)
2017	30 t	48 t	30 t	46 t	Council Regulation (EU) No 2017/127 of 20 January 2017 (3,4)
2018	30 t	48 t	26 t	52 t	Council Regulation (EU) No 2018/120 of 23 January 2018
2019	33 t	50 t	31 t	38 t	Council Regulation (EU) No 2019/124 of 30 January 2019
2020	33 t	50 t	29 t	45 t	Council Regulation (EU) No 2020/123 of 27 January 2020
2021	33 t	50 t	NA	NA	Council Regulation (EU) No 2021/703 of 26 April 2021

For 2021, and under Regulation (EU) No 2021/703 it was stated that the catches shall remain under the quotas as followed:

Raja undulata	**2021** **Union waters of 8 (RJU/8-C)**	**2021** **Union waters of 9 (RJU/9-C)**
Belgium	0	0
France	13	20
Portugal	10	15
Spain	10	15
UK	0*	0*
UE	33	50

*** UK quota not agreed at the time of publication.**

Unwanted catches of skates and rays in subareas 8 and 9 for the period 2019–2021 are regulated by the Commission Delegated Regulation (EU) 2018/2033, reviewed in 2019 (Commission Delegated Regulation (EU) 2019/2237), which establishes the details of the landing obligation in Southern-Western waters. According to this, based on scientific evidences of high survivability, most skates and rays are exempted from the landing obligation. This exemption implies that when discarding skates and rays in the cases referred above, those shall be released immediately, and that during the period 2019–2021, all Member States have to present before 1 May each year additional scientific information supporting the exemption. The Scientific, Technical and Economic Committee for Fisheries shall assess that scientific information by 31 July every year. The exemption applies to:

- All skates and rays (except *L. naevus*) caught by all fishing gears in subareas 8 and 9;
- *L. naevus* caught by trammel nets in subareas 8 and 9;
- *L. naevus* caught by trawls in Subarea 8.

19.2.4.1 Regional management measures

Portugal

The Portuguese Administration adopted, on 29 December 2011, national legislation (Portaria no 315/2011) that *prohibits the catch, the maintenance on board and the landing of any skate species belonging to the Rajidae family, during the month of May along the whole continental Portuguese EEZ*. This applies *to all fishing trips, except bycatch of less than 5% in weight*. The legislation was updated on 21 March 2016 (Portaria no 47/2016) by extending the fishing prohibition period to June.

By 22 August 2014, the Portuguese Administration adopted a national legislation (Portaria no 170/2014) that *establishes a minimum landing size of 52 cm total length (L_T) for all Raja spp. and Leucoraja spp*.

On 19 May 2016, Portugal adopted a legislative framework (Portaria no. 96/2016) regarding the 2016 quota of *Raja undulata* in Division 9.a assigned to Portugal. This framework includes a set of conditions for licensing specific fishing permits to vessels on the owner's request, provided that each vessel fulfils the set of specific conditions which include fishing vessel type, fishing license and historical skate landings. Vessels having the specific fishing permit shall comply with a set of rules, which include obligation to transmit, to both the General Directorate of Natural Resources, Maritime Security and Services (DGRM) and to IPMA, specific fishing data using a form designed by DGRM and IPMA to register haul and catch data on a haul-by-haul basis; the obligation to accept scientific observers duly accredited by IPMA onboard, except in situations where, demonstrably, due to vessel's technical characteristics, it affects the normal activity of the vessel. In 2019, the DGRM introduced a landing control process according to which, in addition to licensed vessels, vessels not possessing the special fishing license were allowed to land a maximum of one specimen per trip and were also obliged to provide additional information on their fishing activity related to *R. undulata* captures.

On each fishing trip, vessels are prohibited from targeting undulate ray and are obliged to land the species under specific conditions: a maximum of 30 kg of undulate ray live weight (for licensed vessels) or one specimen per trip (for non-licensed vessels) is allowed; only whole or gutted specimens can be landed and a minimum (78 cm L_T) and a maximum (97 cm L_T) landing sizes are adopted. During the months of May, June and July of each year the capture, retention onboard and landing of undulate ray is prohibited, but data on catches should be recorded. On 16 January 2017, Portugal updated the 2016 legislative framework regarding the 2017 quota of *Raja undulata* in Division 9.a assigned to Portugal, from 12 to 15 tonnes with no other major differences on the criteria (Portaria no. 27/2017).

France

Based on feedback from scientific programs carried out since 2011 in close partnership with fishermen, it was decided in December 2013 to remove undulate ray from the list of prohibited species, without landings permitted (Total Allowable Catch of zero). In December 2014, thanks to measures proposed by Member States to ensure the sustainable management of local populations of undulate ray, a small TAC has been allowed for France in ICES divisions 7.e-d and 8.a–b, with limited bycatch but no targeted fishing. Since then, the French authorities adopted different decrees to regulate bycatch and landings of undulate ray. Starting in 2016, a legislative framework similar to the one adopted by Portugal was implemented, with landing of undulate ray allowed for a limited number of vessels conditioned by the systematic reporting of catches of this species, a minimum landing size of 78 cm and landing limitations per trip and time period. The obligation of possessing a special permit to land *R. undulata*, which was in place since the dedicated TAC for this species in ICES divisions 8.a and 8.b was set over 0, was lifted in 2019. For more details on the different modalities of this bycatch by year, see Gadenne (2017 WD).

Spain

The Spanish Ministerio de Agricultura, Pesca y Alimentación published in the Resolution of 1 July 2019 the list of species for 2019 that have high survival and that can be released into the sea once captured that affected the stocks of *Raja microcellata* in 7.fg, Rajiformes in 6, 7, 8, 9 and *Raja undulata* in 8.c and 9.

In March 2020, the list of species with exemption of the landing obligation based on high survival was updated (Boletín Oficial Del Estado nº 66, sec. III), following the Commission Delegated Regulation (EU) 2019/2237. The updated list includes all skates and rays (except *L naevus)* caught by all fishing gears in Divisions 8 and 9, *L naevus* caught with trawl in Division 9 and *L naevus* caught with trammel nets in Divisions 8 and 9. The recommendation is to release immediately the unwanted catch of those species below the sea surface.

19.3 Catch data

19.3.1 Landings

Tables 19.1a–e and Figure 19.1 show ICES combined annual landing estimates for all skates, by country.

Table 19.1f gives annual ICES landings by stock and country, and Table 19.2a presents the annual ICES landing estimates, by division for each skate and ray species and in a separate table also landings of Dasyatidae, Myliobatidae, Rhinobatidae, Torpedinidae and Gimnuridae (included in 2020) species (see Section 19.10). Table 19.2b shows the ICES estimates of landings by species and year of the other skates and rays in Subareas 8 and Division 9.a.

Skates in Bay of Biscay and Cantabrian Sea (Subarea 8)

Historically, since 2005 approximately 68% of landings in Subarea 8 were made by France and 31% by Spain (Basque Country included). Since 1973, skate landings show no clear trend, although at the earlier years of the time-series (1973–1974) and in the period from 1982–1991 remarkably high values were registered. From 2005–2019, annual landings were around 1900–3100 tonnes y^{-1}.

In 2020, the divisions with the highest landings were 8.a–b (71%), and these were mostly from France (1043 tonnes). In Division 8.c, landings represented 26% of the total landing of Subarea 8 and were mainly from Spain (450 tonnes). Landings from Division 8.d were only 51 tonnes.

Skates in Division 9.a

In this division, Portuguese and Spanish historical landings since 2005 account for *ca.* 78% and 22%, respectively of reported skate landings. Since 2005, total landings of skates remained relatively stable, at about 1265–1863 tonnes y^{-1}.

From 2005 to 2020, Portuguese mean annual landings were *ca.* 1250 tonnes y^{-1}, with a maximum of 1544 tonnes in 2006 and a minimum of 1012 tonnes in 2015. Spanish mean annual skate landings were *ca.* 345 tonnes, with a maximum of 481 tonnes in 2013 and a minimum of 134 tonnes in 2008.

19.3.2 Discards

Discard information available for Subarea 8 and Division 9.a and country is presented in the Table 19.3.a and included all the stocks in the area for which they have been reported discards.

All the discard estimates presented in this section come from the official data provided by the national DCF programs, and WGEF members consider them reliable data for the advice calculation of some stocks (e.g. rjn.27.8c, rjn.27.9a). However, in the cases in which the historical series are too short or contain significant gaps or missing data (and in most cases also considered negligible) they have been considered not suitable for advice purposes (e.g. rjc.27.8, rjc.27.9a, rjh.27.9a, rjm.27.8, rjm.27.9a).

Although there may be a widespread discarding of skates across fisheries, a proportion of these are likely to survive, particularly in the case of the polyvalent fleets using trammel and gillnets. In these fisheries, discard survivorship varies with soak time.

In WKSHARK3 (ICES, 2017), current sampling programmes for discards were evaluated to examine the suitability for the estimation of discard rates and quantities for the elasmobranch case study considered.

Spain OTB fleet in subareas 8 and 9

The IEO "Spanish Discards Sampling Programme" started in 1988, focused on the Spanish trawl fleets operating in the "Celtic Seas" (ICES subareas 6 and 7) and the "Bay of Biscay and the Iberian coast" (ICES subareas 8 and 9) Ecoregions. However, it did not have annual continuity until 2003, after the Data Collection Regulation (DCR) implementation. According to these data, the most discarded skates by Spanish otter fleet (despite annual variations) are *R. clavata*, followed by *R. montagui* and *L. naevus* (Table 19.3a). Discards from the Basque OTB (Bottom Otter Trawler) fleet in divisions 8.a-b, d indicates that small skate specimens are commonly discarded. *L. naevus* and *R. clavata* are the most discarded species and represent depending on the year 4–53% and 0–52% of the total catches of these species (Table 19.3b).

Portuguese OTB fleet in Division 9.a

Information on discards of elasmobranchs produced by the Portuguese bottom otter trawl fleets (crustacean and demersal fish bottom otter trawlers) operating in Division 9.a has been collected by the DCF Portuguese on-board sampling program since 2003. The routine estimator used to estimate total discards in the Portuguese trawl fisheries does not apply to species with occurrence lower than 30% of the sampled trips, which is the case of all skate and ray species (Serra-Pereira *et al.*, 2017). The low frequency of occurrence registered for skates and rays in Portuguese trawl fisheries indicates that discards from that fleet can be considered negligible for all Iberian skate and ray stocks (Fernandes, 2021). Procedures for estimating the probability of a given species being caught in a haul and of a specimen being discarded, as well as the expected number of discarded specimens per haul, are described in the Stock Annex for each species. The overall discard estimates obtained by species for the two fleets were low.

In 2020, the Portuguese onboard sampling programme was compromised by the pandemic situation due to Covid-19 and the sampling only occurred in the first quarter of the year. For this reason, the sampling effort was not representative of the fishing effort of the Portuguese bottom otter trawl fleets. For the species presenting low frequencies of occurrence in the discards of sampled hauls in the previous sampling period (2016–2019), which is the case of skates and rays, the discards were considered zero or negligible also for 2020 (Fernandes, 2021).

Polyvalent Portuguese fleet in Division 9.a

Discard data for skates were collected during the DCF skate pilot study and the DCF trammel net fishery pilot study targeting anglerfish. The former included fisheries operating in shallow waters (depths < 150 m), whilst the latter examined the fishery operating at depths > 150 m. The frequency of occurrence of rajids was higher in nets operating < 150 m, presumably due to a higher spatial overlap with the species' distributions. For all the skate species, the probability of the species being caught in a haul and a specimen being discarded and the expected number of discarded specimens per haul were low (see Prista *et al.*, 2014 WD and the Stock Annexes for more details).

Under DCF, information on discards from vessels belonging to the polyvalent fleet, particularly those with length overall (LOA) larger than 12 m, using set gillnet and trammel nets to target demersal fish have been collected since 2011, and data were analysed for the period 2011–2014 (Figueiredo *et al.*, 2017 WD). Within the sampled trips (n = 49), seven species of skate were identified in the discards. The main discarded species was *R. clavata,* which occurred in between 13 to 38% of the sampled hauls. The mean proportion in number of *R. clavata* discarded by haul on the sampled trips was between 0.16 and 0.33. Only *R. clavata* had sufficient sampled individuals to analyse the length-frequency distribution of the retained and discarded fractions (Figure 19.2c). However, even for that species the observed length pattern varied between years.

No new information was provided in 2021.

French fleet in Subarea 8

Gill- and trammel net métiers discard a fraction of large fish, which might be considered as damaged fish (e.g. partly scavenged catch). Unlike smaller discarded individuals, a portion of which may survive, these discards are dead discards.

In trawl fisheries, due to the low commercial value of small specimens, the mean size of discarded specimens is much smaller than that of landed specimens. It is likely that some discarded specimens survive.

In 2020, due to the pandemic situation, the opportunities of boarding were reduced for observers. As a consequence, discards could not be estimated for some species that year (e.g. *R. undulata*).

Belgium fleet in subarea 8

Beam trawl reported only discards of *L. naevus* since 2013. Discards amounts are very variable with a minimum of 34 t in 2018 to a maximum of 859 t in 2017. It is worth noting that part of the reported discards may have been caught in subareas 6 and 7.

UK fleet in Subarea 8

UK only reports discard of *L. naevus* ranging from from 33 t to 207 t. Notice that part of the reported discards can belong to the subareas 6 and 7.

19.3.3 Discard survival

WKSHARK3 (ICES, 2017) and WKSHARK 5 (ICES, 2020b) reviewed available studies to identify where there are existing data on at-vessel mortality and post-release mortality of elasmobranch species by area, gear type and identify important data gaps.

Discard survival data available on skates caught in trammel net fisheries (mesh size ≥ 100 mm) in ICES Division 27.9.a, collected under the Portuguese DCF pilot study on skates (2011–2013), and presented in previous reports was re-analyzed and the results summarized in Serra-Pereira and Figueiredo (2019a WD). Experiments were conducted on categorical vitality assessment (CVA) after capture of *R. clavata, L. naevus, R. montagui, R. brachyura* and *R. undulata* and indicate that it is generally high for all species, as the percentage of skates in Excellent and Good vitality status was above 75% for all species, mesh size and soak time considered (Table 19.4a).

- ***R. clavata*** - specimens caught in both mesh size groups with soak time < 24h were mainly found in Excellent condition (100% and 92%, respectively), while those from hauls with > 24h, although most specimens were caught in Excellent condition (72% and

52%), the percentage of Poor/Dead vitality status was comparatively higher (16% and 24%, respectively for each mesh size);

- ***R. brachyura*** - most specimens were caught in Excellent conditions, representing 67% of the observations from mesh size < 180 mm and soaking time < 24h, 92% for the same mesh and soaking time > 24h, 57% and 70% for mesh size > 180 mm for each soaking time period, respectively. The highest percentage of specimens in Poor/Dead status for that species was observed for mesh size > 180 mm and soaking time < 24h (24%);
- ***R. montagui*** - specimens caught with mesh size < 180 mm and in Excellent vitality represented 100% and 67% depending on the soaking time; specimens caught with mesh size > 180 mm and in in Excellent vitality represented 40% and 37%. The percentage of specimens in Poor/Dead conditions was higher for the larger mesh size group (30%) than for the smaller one (0% and 12%);
- ***L. naevus*** - representative data was only obtained for mesh size > 180 mm and soaking time > 24h. Under this situation 58% was the percentage of specimens in Excellent condition while 21% and 21% corresponded to specimens in Good and 21% Poor/Dead condition respectively;
- ***R. undulata*** - the percentage of specimens in Excellent conditions was higher than 79% for all mesh sizes and soak times; highest values observed for mesh size > 180 mm and soaking time > 24h (96%). The percentage of specimens in Poor/Dead conditions was 2% and 5% for mesh size < 180 mm and 3% and 14% for mesh size > 180 mm, respectively for each of the two soaking times considered.

Results suggest that the vitality after capture of a specimen is not related to its size, as for all the species, and regardless of specimens' size (TL < 52 cm and > 52 cm), the majority was found in Excellent vitality condition (60–92%). This indicate that fish below the currently established minimum landing size of 52 cm for all Rajiformes (except *R. undulata*) and 78 cm for *R. undulata* and above the maximum landing size 97 cm for the latter, if released immediately to the water after capture have a potentially high survival capacity.

Additionally, a mark-recapture study (UNDULATA project, 2014–2015) of *R. undulata* caught by trammel nets obtained a return rate of 11% and the mean observed time-at-liberty was of 54 days and maximum of 313 days. These results are a good indication that the species has a potential high long-term survival.

In 2017, an experiment was carried out in the Bay of Bourgneuf (Division 8.a) during which 163 undulate rays were caught using a bottom otter trawl (Morfin *et al.,* 2019). 144 individuals in a good-enough physical condition were equipped with acoustic transmitters and fixed receivers were deployed in the semi-enclosed bay, in addition to occasional tracking with a mobile antenna. The study concluded that a minimum of 49% of the skates survived at least 2 weeks after tagging (with a maximum estimated survival of 97.5% considering at deck mortality). The 49% estimate is a minimal survival rate because it could not be established whether individuals that were not detected after 2 weeks were dead or had wandered outside the detection range of the receivers during the time of the experimentation.

In 2018, new experiments were conducted onboard PTGFS-WIBTS-Q4 and PT-CTS (UWTV (FU 28–29)) surveys to collect CVA and short-term survival estimates (only in the former) for *R. clavata* caught by otter trawl. Overall, most of the specimens were found in Excellent or Good conditions (60–72%), with an at-vessel-mortality of 6–7% (Table 19.4b). All specimens in Excellent vitality status showed tail grab, spiracles and body flex reflexes. The percentage of body flex and tail grab reflexes decreased with vitality status, 71% to 29% and 48% to 29%, respectively. The preliminary estimated survival, based on captivity observations of *R. clavata* during a maximum of 4 days, was 64%.

In 2019, the Project DESCARSEL, conducted by IEO (Spain), performed survivability experiments of cuckoo ray (*L. naevus*) in trawl fisheries operating in northern Portugal fishing grounds (Division 9.a) (Valeiras *et al*., 2019). The study was conducted in April–May 2019 onboard a Spanish commercial trawler and included vitality and captivity observations. From a total of 503 individuals captured, 141 were placed in tanks for survival monitoring. The vitality results showed that 7.6% of the skates (n = 38) were assessed as Excellent condition, 24.1% (n = 121) as Good and 35.2% (n = 177) as Poor, and 33.2% (n = 167) were Dead. Estimated survival at 36h was 27% (21–36%). Maximum survivability at tank captivity was 7 days. Estimated 50% survivability was different for each vitality status. Skates assessed as Poor vitality died in 12 hours after hauling, while those with Excellent vitality lasted 41 hours (1.7 days) and those with Good vitality lasted 24 hours. The low survival estimates obtained from this study resulted on the removal of *L. naevus* caught by trawl in Division 9.a. from the exemption of the landing obligation (BOE, 2020, Nº 66, sec. III).

In 2020, the project SURF studied the survivability of cuckoo ray (*L. naevus*) discarded by French trawlers targeting demersal fish and operating in the Celtic Sea (Division 7h) and northern Bay of Biscay (Division 8a). The sampling, realised on a French commercial trawler, was stratified by vitality class and sampled individuals were landed and their state was monitored during up to three weeks in aquarium facilities in September 2020. Beside this, the vitality status of other discarded individuals was reported by an onboard observer during fishing trips carried out during winter, spring and summer aboard four different trawlers. The final survival rate ranged from 12% to 22% and was mainly influenced by haul duration and weather conditions (wave height).

To note that all the experiments here described followed the procedures described in previous studies on the survival of this group of species and the recommendations made by the STECF and the ICES Working Group on Methods to Estimate Discard Survival.

In early 2021, ICES conducted a workshop on the inclusion of discard survival in stock assessments (WKSURVIVE; ICES, 2021a). It was recognized that this continues to be an active research, particularly in what regards discard survival of skates and rays, due to its link to the EU conditional survivability exemption and associated evidence roadmap. Due to the complexity and specifications across stocks, it was recommended that the task of including discard survival into stock assessments should be driven by stock assessment groups. To avoid the long benchmark process, this group recommended an inter-benchmark meeting to address the inclusion of discard survival across multiple stocks within the same meeting, to accelerate the process.

19.3.4 Quality of the catch composition data

Species composition of landings in Subarea 8 and Division 9.a, corrected according to the WKSHARK2 reporting guidelines (ICES, 2016) are presented (Tables 19.1f and 19.2). In recent years, official landings reported as Rajiformes (indet.) have declined because of the EU mandatory species-specific reporting. In the case of the Portuguese official landings statistics, eight commercial designations were reported in 2017: "raia lenga" (*R. clavata*), "raia pontuada" (*R. brachyura*), "raia manchada" (*R. montagui*), "raia-de-dois-olhos" (*L. naevus*), "raia de S. Pedro" (*L. circularis*), "raia-zimbreira" (*R. microocellata*), "raia-de-quatro-olhos" (*R. miraletus*) and "raia bicuda" (*D. oxyrinchus*).

Landing misidentifications and/or coding errors still occur in Subarea 8 and Division 9.a. To address this, IPMA developed statistical procedures to better estimate species-specific landings during the DCF skate pilot study (2011–2013) (Figueiredo *et al*., 2020c). Table 19.5 gives updated landing proportions for each skate species (see Stock Annex for more details on the method). After this study, DCF sampling effort for skates decreased, and the precision of the estimates has decreased accordingly. An increment in sampling effort is recommended, ideally included in the

Portuguese DCF program. Since 2017, a dedicated sampling programme on skate and ray species composition, incorporated in the DCF, was implemented in the main landing ports (Matosinhos, Póvoa do Varzim, Peniche, Sesimbra and Setubal). Within this, extra samples are being collected with the objective of collecting more information on the comparison of market labels and the species being landed. These samples are combined with those from the DCF concurrent sampling and used to estimate the Portuguese species-specific landings using the statistical procedure mentioned above.

A similar pilot-study in the same period (2011–2013) was implemented by AZTI in Division 8.c. The main objective of the Basque Country pilot study was to characterize the main fishing parameters of the trammel net fishery (fishing gear, métier, effort and LPUE) and to identify the skate species present in the landings, as well as biometric relationships such as "wing weight/total weight" and "total length/wing width", to better estimate the live weight of the landed skates.

In France, it is requested that all landings be recorded at species level. The quality of species reporting has improved in the last decade. Although auction markets now use identification guides and record sales accordingly, some misidentification is still likely to occur. Since 2012, a dedicated program "Elasmobranch on Shore" aims to collect data on mislabelling in the main French auctions. Since 2018, the survey targets two auctions being considered as the most relevant in terms of landings for the Bay of Biscay. Each auction is visited every month and each selling name is sampled from all landing vessel in order to determine the level of mislabelling into those auctions (Mayot and Barreau, 2021). Generic selling names such as *Raja spp.* Have been less used since 2014 but elasmobranch species are still mislabelled or mixed with other species such as teleosts. Fleets frequenting those auctions are mainly small units going at sea for one to three days so quantity landed per unit can be low and mislabelling often considered as minor and need to be analysed together. Due to the complexity and diversity of the mislabelling, ongoing work is done to be able to correct efficiently the landing data in this area in years to come.

19.4 Commercial catch composition and length frequency distribution

Subarea 8

Length–frequency distributions of the retained and discarded catches of *R. clavata, L. naevus*, *R. montagui and R. undulata* from Basque (Bottom Otter Trawl) and French fleets (bottom trawl and nets) are presented (figures 19.2a-b).

In the Basque Bottom trawl *L. naevus* and *R. clavat*a are discarded in all size range and only the individuals larger than 30–35 cm are retained.

In the French fleets, only the individuals of *R. clavata* larger than 50 cm are retained, while larger individuals of *R. undulata* are landed (the species has a minimum conservation reference size of 78 cm TL). Some individuals of *L. naevus* below 50 cm TL are sometimes retained as well. For *R. montagui*, the length distribution of discarded individuals cannot be estimated.

Division 9.a

Length–frequency distributions of *R. clavata, R. montagui, L. naevus* and *R. microocellata* from the Portuguese commercial polyvalent and trawl fleets for the period 2008–2020 are presented in figures 19.2d–g. Length–frequency distributions were extrapolated to the total estimated landed weight of each species. Within each fleet, length distributions and their ranges were similar between years. However, for some species, there were differences in length distributions between the polyvalent and trawl fleets. Note that for *R. microocellata* the length–frequency distribution is only presented for the polyvalent fleet, due to the low occurrence of this species in landings from the trawl fleet.

Length data on *R. brachyura* are available from four different sampling sources that resulted from different research programs which have in common the same sampling strategy for collecting length data. The density plots of length by sampling source and fishing segment are presented in Figure 19.2h. In the early years of the time series the sampling effort was reduced and the corresponding length frequency distributions for the exploited population reflect that and should be analysed with caution.

19.5 Commercial catch–effort data

19.5.1 Spanish data for Subarea 8

An updated nominal LPUE-series for the Basque Country's OTB DEF>=70 and OTB DEF=100 in Subarea 8 from 2001–2019 presented in 2020 was not updated (Table 19.6; Figure 19.3).

19.5.2 Portuguese data for Division 9.

19.5.2.1 Effort data

In the Portuguese continental coast, Rajidae species are mainly landed by the polyvalent segment followed by trawl. In 2019, the landed weight of Rajidae derived from the polyvalent segment represented 82% of the total landings. This fishing segment is characterized by multi-species and mixed fisheries and includes vessels with length overall (LOA) ranging from 5 to 27 m, which generally operate between 10 to 150 m deep (but can fish down to 600 m deep). The analysis of DCF sampling data indicates that Rajidae are mainly caught by trammel nets, which is considered to be the most appropriated gear to catch these species.

Annual landings by species are calculated using the official daily landings data set and market sampling data collected under DCF according to the procedure described in stock annexes and in Figueiredo *et al.* (2020c).

Fishing effort time series (2008–2020) for each fleet segment, polyvalent and trawl, were analysed. Consistently increasing or decreasing trends (monotonic) on the fishing effort data collected over time were investigated and the non-parametric Mann-Kendall trend test was applied (https://cran.r-project.org/web/packages/Kendall/Kendall.pdf). For each fishing segment, the test was applied to the last 10 years of the fishing effort series, considering the number of fishing trips with landings of Rajidae species as sampling unit. The fishing effort time series for each fishing segment is presented in the following table:

Year	No Fishing trips	
	Polyvalent	Trawl
2008	36149	6513
2009	36239	5683
2010	34767	5461
2011	36761	5139
2012	32565	5158
2013	28007	4658
2014	25779	4471
2015	25723	4325
2016	24476	4593
2017	25296	4237
2018	24761	4566
2019	24561	4492
2020	27464	4650

For the polyvalent segment, the plot of the fishing effort time series with lowess smooth suggests a downward trend and the autocorrelation in this data series does not appear significant (Figure 19.4.a), which is confirmed by the results of the Mann-Kendall trend test applied to the last 10 years of the fishing effort series for this fleet (tau = -0.6, p-value = 0.02).

As observed for the polyvalent fleet, the fishing effort time series plot with lowess smooth for the trawl segment, suggests a downward trend (Figure 19.4.b). Yet, when considering the last 10 years of the time series for this fleet the Mann-Kendall trend test is not significant, indicating that there is no trend in the data, and can be therefore considered stable (tau = -0.33; p-value = 0.21). The autocorrelation for the same period does not appear significant (Figure 19.4.b). The overall decrease in fishing effort observed for both fleets may be related to several factors including the inclusion of *R. undulata* in the prohibited species list in 2009, the implementation of seasonal closures since 2012, and changes in the target species in some polyvalent fleets.

19.5.2.2 CPUE and Effort data

Standardized LPUE (kg trip^{-1}) time-series (2008–2013) for the most representative skate species (*R. clavata, R. montagui, R. brachyura, L. naevus* and *R. undulata)* were determined based on fishery data collected under the DCF skate pilot study on skates in Division 9.a. Standardized LPUE indices for *L. naevus* were calculated for both the polyvalent and trawl fleets (the two fleets each contribute *ca.* 50% each of the annual landings). For the remaining species, standardized LPUE indices were only calculated for the polyvalent fleet. Methodological procedures to calculate standardized LPUE are described in the Stock Annex for rjh.27.9a.

In 2021, standardized LPUE was updated for *R. brachyura* (see Section 19.9.11 for more details) *R. montagui* (see Section 19.9.7 for more details), *Raja clavata* (see Section 19.9.2 for more details) and *Leucoraja naevus* (see Section 19.9.5 for more details) in Division 9.a.

For *R. undulata* a CPUE time-series is being developed through the adjustment of a zero-truncated poisson regression model using fishery dependent data collected since 2016 (see Section 19.9.10 for more details on perliminar results).

19.5.3 Quality of the catch-effort data

Under the 2011–2013 DCF pilot study on skates developed by IPMA in Division 9.a, the quality of catch and effort data by species has improved greatly. It is recommended that catch-effort data by species continue to be collected, and focused sampling effort be undertaken for more coastal species.

19.6 Fishery-independent surveys

Groundfish surveys provide data on the spatial and temporal patterns in species composition, size composition, relative abundance and biomass for various skates. The fishery-independent surveys operating in the Bay of Biscay and Iberian Waters are discussed briefly below (see Stock Annex for further details).

Due to the patchy (mainly coastal) distribution and habitat specificity of some skate species (e.g. *R. undulata, R. brachyura* and *R. microocellata*), existing surveys do not provide reliable information on abundance and biomass. In order to gather information on the distribution and spatio-temporal dynamics, and on abundance and biomass for those species, WGEF recommends dedicated surveys using an appropriate fishing gear be developed in this ecoregion.

19.6.1 French EVHOE survey (Subarea 8)

The EVHOE-WIBTS-Q4 survey has been conducted annually in the Bay of Biscay since 1987 (excluding 1993, 1996 and 2017). The survey is usually conducted in October and November (but was undertaken from mid-September to end-October in 1989, 1990, 1992 and 1994, and in May during 1991). In 1988, two surveys were conducted, one in May the other in October. Since 1997, the main objectives have been: i) the construction of time-series of abundance indices for all commercial species in the Bay of Biscay and the Celtic Sea with an emphasis on the yearly assessed species where abundance indices at-age are computed; ii) to describe the spatial distribution of the species and to study their inter-annual variations; and iii) to estimate and/or update biological parameters (e.g. growth, sexual maturity, sex ratio).

Population indices from the French EVHOE-WIBTS-Q4 survey were calculated for all elasmobranchs caught. For skates and rays, indices of abundance and biomass per year are only considered reliable for *L. naevus* and *R. clavata* only. For other species, the small numbers commonly taken (except in some few occasional hauls with high catches) do not allow reliable estimates.

19.6.2 Spanish survey data (divisions 8.c and 9.a)

The Spanish IEO Q4-IBTS annual survey in the Cantabrian Sea and Galician waters (divisions 8.c and 9.a) has covered this area since 1983 (except in 1987), obtaining abundance indices and length distributions for the main commercial teleosts and elasmobranchs. The survey has a stratified random sampling design, with the number of hauls allocated proportionally to the area of each stratum. Results for elasmobranch species sampled in the IEO Q4-IBTS survey on the Northern Iberian shelf (Division 8.c and northern part of 9.a) were presented by Fernández-Zapico *et al*. (WD04 – 2021). Depth stratification ranges from 70–500 m, therefore, catch rates of shallower species, such as *R. undulata*, are low and cannot be used to estimate abundance or biomass indices. More information on this survey is given in the Stock Annex and WKSKATE report (ICES, 2021c).

The Spanish bottom trawl survey IBTS-GC-Q1-Q4 (ARSA) in the Gulf of Cadiz (Division 9.a) has been carried out in spring since 1993 and in autumn since 1997 up to date 2020. Despite COVID-

19 issues both surveys were conducted in 2020. The surveyed area corresponds to the continental shelf and upper-middle slope (depths of 15–800 m) and from longitude 6º20'W to 7º20'W, covering an area of 7224 km^2.

19.6.3 Portuguese survey data (Division 9.a)

The Portuguese Autumn Groundfish Survey (PtGFS-WIBTS-Q4) is conducted by IPMA (Cardador *et al*., 1997). *R. clavata* is the most frequent skate species caught (88% of the total weight of skates). For most of the time series the PtGFS-WIBTS-Q4 was conducted onboard the R/V *Noruega* and used a Norwegian Campelen Trawl (NCT) gear with rollers in the groundrope, and 20 mm codend mesh size (ICES, 2015a). In 1996, 1999, 2003 and 2004 the R/V *Noruega* was unavailable, and the surveys were conducted by the RV *Capricórnio*, using a FGAV019 bottom trawl net, with a 20 mm cod-end mesh size and a ground rope without rollers. In 2012, no vessel was available to conduct the survey. In 2018, due to mechanical problems in R/V *Noruega*, part of the PtGFS-WIBTS-Q4 survey (i.e. 12 stations) was conducted onboard the commercial trawler *Calypso* (Dimensions = 24.8 m * 7.8 m, Ton = 215 tonnes), using a FGAV019 bottom trawl net, with a 20 mm codend mesh size and a ground rope without rollers, which covered the Alentejo coast (strata LIS, SIN, MIL and ARR) (Serra-Pereira and Figueiredo, 2019b WD). Those years in which the PtGFS-WIBTS-Q4 survey was conducted with a different vessel and gear were excluded from abundance and biomass analyses (Figueiredo and Serra-Pereira, 2013 WD; Serra-Pereira and Figueiredo, 2019b WD).

The Portuguese crustacean trawl survey/*Nephrops* Survey Offshore Portugal (NepS (FU 28–29)) is conducted on R/V *Noruega* and uses a FGAV020 bottom trawl with 20 mm codend mesh size. No vessel was available to conduct this survey in 2004, 2010, 2012, and in 2019 (ICES, 2012).

In 2018, PtGFS-WIBTS-Q4 had technical problems, and part of the stations were sampled using a commercial trawler and a different fishing net (using FGAV019 instead of NCT). This had negative effects particularly on the catch of *R. montagui* from Division 9.a (rjm.27.9.a), for which no biomass/index could be obtained (see Section 19.9.7 for more details).

In 2019, both PtGFS-WIBTS-Q4 and NepS (FU 28–29) were not conducted due to issues external to IPMA. In 2020, PtGFS-WIBTS-Q4 was carried out in the new RV "Mário Ruivo" (Dimensions = 75.6 m * 15 m, Ton = 2290 tonnes) and only 6% of the planned number of fishing hauls was achieved; this was due to a combination of legal/logistic constraints and COVID-19 pandemic that largely delayed the start of the survey until the end of the official time period (4th quarter) and year. NepS (FU 28–29) was not conducted, not due to the CoVid-19 pandemic, but to legal constraints of national scope that turned unfeasible the hiring of fishing and vessel crew on time to undertake the survey. The two surveys are planned to be conducted in 2021 with the RV "Mário Ruivo". Due to the use of a new survey and different gear on the PtGFS-WIBTS-Q4 the continuation of the time series of both surveys in the future is uncertain and needs further investigation.

19.6.4 Temporal trends

French EVHOE-WIBTS-Q4 Survey (Subarea 8)

The biomass index of *L. naevus* shows an increasing overall increasing trend since 2000 (Figure 19.5a). *L. naevus* is distributed mainly in the northern area (Division 8.a) of the Bay of Biscay near the continental slope.

R. clavata showed no clear temporal trend over the time series within general index values lower than 10 with an important peak in 2001 (but with a wide confidence interval, Figure 19.5b). *R* *clavata* is commonly caught in certain fishing hauls. It is distributed mainly in the northern and central areas of the Bay of Biscay, from coastal waters to the upper continental slope.

R. brachyura is always found near the coast but was recorded only in a few hauls in the north of Division 8.a. This species was not caught between 1991 and 2010.

R. undulata occurs only in a few shallow hauls close to the coast. Its distribution goes from the northern parts of Division 8.a to the southern parts of Division 8.b. *R. undulata* was not caught in numerous years before 2018.

Spanish IEO Q4-IBTS survey (Divisions 8.c and 9.a)

In 2020, of the five main elasmobranch catches per haul three were skates: *Raja clavata (10%), R. montagui (4%)* and *Leucoraja naevus (1.8%)* (WD04 - Fernández-Zapico *et al*., 2021). In 2020, the biomass of *R. clavata* slightly decreased, *L. naevus* remained similar to the previous year, whereas the biomass of *R. montagui* decreased again in 2020 though still maintaining the medium-high values of the time series. As in previous years, only a few specimens of *L. circularis and R. undulata* were caught. Besides some individuals of the species *R. brachyura, Torpedo marmorata, Tetronarce nobiliana* and *Dipturus oxyrinchus* and Raja sp. were also caught in 2020. On the contrary other occasional species such as *Neoraja iberica, D. nidarosiensis* and *R. microocellata* were not caught this year.

R. clavata: The biomass of the most abundant ray in the area, *R. clavata*, slightly decreased in both divisions in 2020. Even so, it remained between the medium-high values of the time series (Figure 19.6a). In Division 9.a, *R. clavata* is historically scarcer than in 8.c, however the mean biomass of the last two years was quite higher than the previous five years in 9.a and slightly lower in 8.c (Figure 35). The geographical distribution of *R. clavata* remained similar to the previous year, with greater abundance in the North of Galicia and also in the eastern Cantabrian Sea (Figure 19.6b). Sizes ranged from 13 to 102 cm in 2020, with a higher proportion of specimens from 13 to 51 cm, compared to the whole series (Figure 19.6c).

R. montagui: The biomass of *R. montagui* is lower than that of *R. clavata* and declined again in 2020 after a peak in 2018 but remains at a high level compared to the whole time-series. The mean biomass of the last two years was slightly below the mean value for the previous five (Figure 19.7a). In 2020, the spatial distribution was similar to the previous year (Figure 19.7b) and the length distribution ranged from 23 to 74 cm, showing a slightly higher abundance of medium size (40-55cm) individuals compared to the long-term average length distribution and absence of the smallest and largest individuals (Figure 19.7c).

L. naevus: In 2020, the biomass of *L. naevus* remained similar to the previous year, very stable and at high level since 2018. The mean biomass of the last two years was well above than the previous five years (Figure 19.8a). *L. naevus* was absent in Division 9.a and widespread in 8.c as usual. The large spot of biomass found in the Cantabrian Sea between 6º and 7º W longitude since 2018 was present again in 2020 (Figure 19.8b). The length distribution remained similar to previous years, it ranged from 29 to 66 cm, with a highest proportion of individuals around 60 cm (Figure 19.8c).

Portuguese surveys (Division 9.a)

Raja clavata (13–110 cm L_T) is found along the whole Portuguese coast, from 23 to 751 m depths, but is more common south of Cabo Carvoeiro and in waters shallower than 200 m (Figure 19.9a). Biomass and abundance indices have been relatively stable from 1990 to 2014 and then increased since 2015 (Figure 19.9b). The values in 2017 and 2018 were the highest in the time series. The mean annual biomass index for 2017–2018 (0.60 kg h^{-1}) was 56% greater than observed in the preceding five years (2012–2016; 0.39 kg h^{-1}). The mean annual abundance index for 2017–2018 (1.68 ind. h^{-1}) was 103% greater than observed in the preceding five years (2012–2016; 0.83 ind h^{-}

[1]). The length-distribution was relatively stable along the time series, with the mean length above average in 2017 and 2018 (Figure 19.9c).

Leucoraja naevus (14–65 cm L_T) is found along the whole Portuguese coast, from 55 to 728 m deep, but is more common south of Cabo Espichel and in waters shallower than 500 m (Figure 19.10a). Biomass and abundance indices have been variable in the last seven years, with 2014–2015 showing a slight increasing trend within the average values for the time-series (Figure 19.10b). No *L. naevus* were caught in the 2016. In 2017, the species was only caught in one station. The observed lower catches of *L. naevus* do not follow the increasing trend observed in the Spanish IBTS-GC-Q1-Q4 (ARSA) bottom trawl survey in the Gulf of Cadiz. No technical reason was found for the low catchability observed for the species in the last two years, apart from the later timing of the survey conducted in 2017, July/August instead of May/June (C. Chaves *pers. com.*). Mean annual biomass index for 2017–2018 (0.08 kg h^{-1}) was 12% smaller than observed in the preceding five years (2012–2016; 0.09 kg h^{-1}). Mean annual abundance index for 2017–2018 (0.44 ind h^{-1}) was 46% higher than observed in the preceding five years (2012–2016; 0.30 ind h^{-1}). The length-distribution has been variable during the time series, mainly due to higher catches of juveniles in certain years (Figure 19.10c).

Raja montagui (21–71 cm L_T) is found along the whole Portuguese coast, from 21 to 455 m depths, but more common off the southwest coast of Portugal, at depths of 40–150 m (Figure 19.11a). In 2018, the species was only caught by the commercial trawler used to do additional stations in the southwest coast. Therefore, the estimated survey index, considering only the stations from R/V *Noruega*, was 0 (Serra-Pereira and Figueiredo, 2019b WD). Biomass and abundance indices have been stable since 2014, and above the average values for the time-series (Figure 19.11b). Mean annual biomass index for 2017–2018 (0.09 kg h^{-1}) was 52% smaller than observed in the preceding five years (2012–2016; 0.18 kg h^{-1}). The mean annual abundance index for 2017–2018 (0.25 ind h^{-1}) was 40% smaller than observed in the preceding five years (2012–2016; 0.41 ind h^{-1}). The length-distribution has been relatively stable along the time-series, with the mean length above the average in 2016 and slightly below the average in 2017 (Figure 19.11c).

Spanish IBTS-GC-Q1-Q4 (ARSA) bottom trawl survey in the Gulf of Cadiz (Division 9a South)

In the ARSA time series survey (1993–2020), the most abundant skates are *L. naevus* and *R. clavata.* In 2020, the biomass of *R. clavata* decreased compared to 2019, particularly in the autumn survey however it remains amongst the high values of the time series. In the case of *L. naevus* the biomass index sharply decreased in the last two years 2019 and 2020 in both surveys (Figure 19.12a).

Both species showed an increasing trend in biomass since 1997, with the highest values reached in 2013, 2015, 2018 and 2019, although since 2013 the biomass shows large year-to-year variations. The values in 2020 decreased slightly for *R. clavata* remaining close to 2.0 kg haul whereas *L. naevus* shows a decreasing trend since 2018 remaining at very low values of the time series (0.34 kg haul) (Figure 19.12b).

Despite being variable, abundance indices (nº ind per haul) of *R. clavata* and *L. naevus* show an increasing trend over the time series since 1997. The highest abundance value of *R. clavata* were recorded in the autumn 2013 and 2015 but has slightly decreased in the last 3 years (2018–2020). The abundance of *L. naevus* after the peak in 2017 has strongly decreased in 2019–2020 to the lowest values of the time series (Figure 19.12c).

19.7 Life history information

Available biological parameters of the main species from Portuguese Iberian waters are shown in table 19.7.

Data on the life-history traits of *R. undulata* in the Bay of Biscay are also available (Stéphan *et al.*, 2014a). The length of first maturity was estimated to be 81.2 cm for males (n = 832) and 83.8 cm for females (n = 94). Exploratory growth analyses based on increase in size between tagging and recapture of a small number of tagged *R. undulata* for which size-at-recapture was recorded were consistent with growth estimates for the species in Portuguese waters. More information including diet and a trophodynamic model for the northern part of Division 9.a is available in the Stock Annex.

19.7.1 Ecologically important habitats

Recent studies have provided information on ecologically important habitats for *R. clavata*, *R. brachyura*, *R. montagui*, *R. microocellata*, *R. undulata* and *L. naevus* in Portuguese continental waters (Serra-Pereira *et al.*, 2014). Sites with similar geomorphology were associated with the occurrence of juveniles and/or adults of the same group of species. For example, adult *R. clavata* occurred mainly in sites deeper than 100 m with soft sediment. Those were also considered to be habitat for egg-laying of this species. *Raja undulata* and *R. microocellata* occurred preferentially on sand or gravel habitats. Potential nursery areas for *R. brachyura*, *R. montagui* and *R. clavata* were found in coastal areas with rock and sand substrates. Further details are given in the Stock Annexes.

Information from trawl surveys on catches of (viable) skate egg-cases is considered valuable to further identify ecologically important habitats. Further information could be collected in trawl surveys.

19.8 Exploratory assessments

Previous analyses of the skates in this ecoregion were based on commercial LPUE data and on survey data. Updated analyses were conducted (see below).

19.8.1 *Raja clavata* in the Bay of Biscay

A Bayesian production model was fitted to total catch in divisions 8.a-b and 8.d and EVHOE survey biomass indices (Marandel *et al.*, 2016; ICES, 2020a).

19.8.1.1 Exploratory length-based indicators

A sample of thornback ray landed from fisheries in the Bay of Biscay was measured as part of a French project aiming at a close-kin estimation of the abundance of the stock (http://www.asso-apecs.org/-GenoPopTaille-.html). This length distribution was used in 2018 to fit the LBI and LBSPR (ICES, 2018).

19.8.2 *Raja undulata* in Divisions 8.a-b

An exploratory assessment based on a mark-recapture approach using data from two project (RAIEBECA and RECOAM) collected from 2011 to mid-2014 in the Bay of Biscay contributed greatly to knowledge of the spatial distribution, movements and biology of *R. undulata* (see ICES

(2020) for a full account). An explanatory assessment using length-based indicators was performed for years 2016–2017 and 2018–2019 based on data collected by the onboard observation programme (DCF programme) on French fishing vessels in divisions 8.a-b (Baulier, 2020 WD). The assessment used the eight indicator ratios recommended by WKLIFE (ICES, 2015b) and combined catch data from bottom trawls and trammel nets raised to the corresponding fleets. The reference indicator ratio $L_{mean}/L_{F=M}$ (mean length of individuals larger than the length at first capture over the theoretical average length resulting from exploitation with a fishing mortality equal to natural mortality, which is a proxy for F_{MSY}) suggested that the stock was exploited with a fishing mortality lower than F_{MSY}. However, due to deviations from assumptions necessary to the derivation of reference points (especially steady state and knife-edge selectivity), the actual difference between current fishing mortality and F_{MSY} could not be estimated. Nevertheless, this diagnosis appeared to be robust to the values survival rate of discards applied, the degree of smoothing of the length distribution and the time period considered (2016–2017 or 2018–2019).

19.9 Stock assessment

Given the limited time range of species-specific landing data, and that commercial and biological data are often limited, the status of most skate stocks in this ecoregion is based primarily on survey data, following the Category 3 of the ICES approach to data-limited stocks. Further analyses of survey data (see Section 19.6) and catch rates were undertaken. Due to the absence of survey data for some of the species in this ecoregion (e.g. rjh.27.9a, rju.27.9a, rjm.27.9a), other approaches were adopted for the advice (e.g. LPUE or self-sampling data).

In this section, data and analyses are summarized by stock units for which ICES provides advice.

Assessments are carried biennially and were not fully updated in 2020.

19.9.1 Thornback ray (*Raja clavata*) in Subarea 8 (Bay of Biscay and Cantabrian Sea) (rjc.27.8)

The advice for 2021–2022 was recalculated starting from the advised landings for 2015–2016. The combined index of the two surveys indicates that the stock size indicator has been stable over the longer time series. In the Spanish IEO Q4-IBTS survey the biomass of the most abundant ray in the area, *Raja clavata,* showed a decrease in 2018.

The analysis of French on-board observations shows that *R. clavata* is caught in a significant proportion of hauls only by the OTT_DEF métier, which operates mainly offshore in the Bay of Biscay. For this métier, the indicator suggested an increasing trend since 2007 (Figure 19.13a). The occurrence in other métier is lower and does not show clear signal. For this stock, however, onboard observations may not sample effectively some of the coastal sites of local abundance that occur in some bays and estuaries, such as the Gironde.

Marandel *et al*. (2016) developed a Bayesian state-space model with landings and limited survey (EVHOE-WIBTS-Q4) data to estimate population biomass in the Bay of Biscay. This exploratory assessment concluded that the estimated biomass of *R. clavata* in 2014 was *ca.* 3% of carrying capacity. However, this conclusion should be made carefully because indices of abundance and biomass per year from the EVHOE-WIBTS-Q4 survey can be highly variable for *R. clavata*, so may not be robust, and there is also uncertainty in the longer time-series of landings data.

A larger sample of tissue (fin clips) of landed thornback ray was collected in the Ifremer GenoPopTaille project, funded by the National Agency for Research (ANR). The length distribution of this sample was considered representative of landings from divisions 8.ab and 8.d and used for exploratory length-based indicators (LBI and LBSPR). The length-distribution in this sample was not compared to data from Division 8.c.

19.9.2 Thornback ray (*Raja clavata*) in Division 9.a (west of Galicia, Portugal, and Gulf of Cadiz) (rjc.27.9a)

19.9.2.1 Assessment carried out in 2020

The status of this stock is evaluated based on survey data derived from the Portuguese Autumn Groundfish Surveys (PtGFS-WIBTS-Q4; Figure 19.9b) and the Spanish ARSA survey in Gulf of Cadiz (SpGFS-GC-WIBTS-Q1 and SpGFS-GC-WIBTS-Q4; Figure 19.12a and 19.12b). The biomass index from the PtGFS-WIBTS-Q4 was stable over the overall series. The PtGFS-WIBTS-Q4 was not conducted in 2012 and 2019. Both ARSA surveys series indicate a long-term increasing trend (from 1997–2017 and 2018 with a stable biomass status since the spring 2017).

Combined survey data suggest an increasing trend since 1997 with maximum values observed in the most recent years of the series. Following the ICES DLS approach for Category 3 stocks, the annual trend on the combined surveys (each survey scaled to their average for the overall period) has increased consistently for the overall period.

The ratio between the average biomass index for the last two years (2018–2019) and the average of the biomass index for the reference period (2013–2017) was 1.32.

Auxiliary information provided by the Spanish IEO Q4-IBTS survey in 9.a North, where *Raja clavata* is the most abundant ray caught in the area, also showed an increasing trend in the biomass. Due to the irregular catches of *R. clavata,* this survey is not used in the assessment.

Discard data although included in the previous advice, was not included in 2020, as they are incomplete, since only Spanish data is available but considered negligible (only representing 1–2% of the total catch for the stock).

19.9.2.2 Exploratory LPUE

An alternative assessment approach for this stock using a standardized commercial LPUE series was presented in the WKSKATE meeting (Serra-Pereira *et al.*, 2020 WD; ICES, 2021b), as a consequence of the data availability issues with the PtGFS-WIBTS-Q4 survey in 2018–2020. The method; also applied to other Iberian stocks, is already used for advice on rjh.27.9a and is described in the stock annex for this stock. In brief, it considers the estimated landed weight of the species per trip (fishing effort unit) from the polyvalent fleet using nets, which represents around 80% of the total landings for the stock. To note that the thornback ray and other skate species are a by-catch of such fisheries, generally targeting other and more valuable species (e.g., sole, seabass, anglerfishes, etc.). The landed weight per trip is obtained applying the stepwise statistical methodology described in Figueiredo *et al.* (2020c), in which the vessels are stratified by size and fishing seasonality. Vessels classified in the same *strata* are known to operate similarly in terms of fishing time, size of gear and fishing areas (e.g., smaller vessels tend to operate closer to shore than bigger vessels). The fishing areas exploited by the polyvalent fleet in 9.a have not changed over years and survey data suggest no alterations of the distribution area of the species. So that, it is unlikely that LPUE are not reflecting the biomass in the exploited areas. The fishing trip was adopted as the effort unit because most of the vessels from the polyvalent fleet do not have logbook. The inclusion of variables in the model that inform on the stratification of the fleet allows to have homogenous vessel strata with similar fishing operations. Also, from information collected through inquiries to the Portuguese fleet, the duration of fishing trips from most vessels is around 24h which is equivalent to using the "trip" as fishing effort unit.

Several explanatory variables were investigated as potential candidates and the best model was selected using graphical analysis of residuals and AIC. Those included in the best GLM model (explained variance = 0.80, AIC = 651 723) were: year, quarter, landing port, vessel size, fishing seasonality on skates and rays and fishing gear (trammel nets or gillnets) (Figure 19.4c). Annual standardized estimates of LPUE and the corresponding standard error were calculated for a reference condition of the variables included in the model apart from the year level. For comparison purposes with the current assessment methodology, the LPUE data series was normalized to the long-term mean and compared with the normalized biomass Index obtained from the PtGFS-WIBTS-Q4 survey (Figure 19.4d). In general, both time-series followed similar increasing trends since 2008, and LPUE estimates are within the range of the CI.

So, in order to include the new LPUE series as basis to provide advice for rjc.27.9a in 2022 in the absence of the PtGFS-WIBTS-Q4 survey, the method was presented (Serra-Pereira *et al*., 2020 WD) and evaluated during WKSKATE and peer-reviewed by an external review group, as a recommendation from ICES ACOM (ICES, 2021b). In brief, WKSKATE acknowledged the adequacy of the Portuguese commercial LPUE series to assess the status of this stock and accepted its use for the next advice, due in 2022; the reviewers also recognized the choice made by the group to look at the use of LPUEs as an alternative to surveys and made suggestions for further improvement. Some of those include the use of more appropriate residual analyses based on the Gamma distribution and comparison with the survey series using the same season (Q4) as a reference level. The main concern from the reviewers about the methodology proposed was the non-inclusion of the zeroes in the analysis. The justification for this approach relies on the fact that the thornback ray is a by-catch species for the polyvalent fishery and has a patchy distribution. Therefore, the absence of the species in the catch is more related to the fishing strategy of the fleet than to the species' abundance. Considering the zeroes along with the positive landings of the species in the LPUE analyses could lead to further uncertainty in the results, as the absence of a species in landings can be a consequence of fishing outside its distributional area and not a consequence of decrease in abundance. Additional analysis of the effect of zeroes in the model will be presented in 2022.

In 2021, the model was updated (explained variance = 0.81, AIC = 699 381) (Figure 19.4d). The best model selected with the updated dataset included all the variables mentioned for the previous model. The mean annual biomass index (kg/trip) scaled by the overall mean for 2019–2020 was 12% greater than the observed in the preceding five years.

19.9.2.3 Exploratory length-based indicators

The LBI indicators for rjc27.9.a caught by the Portuguese polyvalent fleet, which represents around 80% of total landings in Portugal, are presented in Table 19.8a (considering 5 cm length classes). These results were expected as threshold levels are considered inappropriate for elasmobranchs. As discussed in WGEF 2020, the most reliable indicator is the MSY related indicator (L_{mean}/LF=M) which suggest that the rjc.27.9.a stock is exploited at sustainable levels. Despite being below the threshold adopted (WKLIFE V), the values in 2018 and 2019 are very close to 1.

19.9.3 Cuckoo ray (*Leucoraja naevus*) in subareas 6-7 (Celtic Sea and West of Scotland) and divisions 8.a-b,d (Bay of Biscay) (rnj.27.678abd)

This stock is addressed in Section 18, Skates and rays in the Celtic Seas

19.9.4 Cuckoo ray (*Leucoraja naevus*) in Division 8.c (Cantabrian sea) (rjn.27.8.c)

The status of this stock in Division 8.c is evaluated based on survey data from the Spanish (IEO) survey in the North of Spain (SP-NGFS-Q4-IBTS). In 2019, the catch rate in this survey was similar to the previous year (0.63 kg $haul^{-1}$), remaining among the highest values of the time series (Figure 19.8a). The ratio between the mean biomass index of the last two years was well above the previous five years resulting in 1.26 (Figure 19.8a). Regarding its geographical distribution in the area *L. naevus* was absent in the 9.a Division and widespread in the 8.c as usual. The large spot of biomass found in the Cantabrian Sea between 6º and 7º W longitude the previous year is present again in 2019 (Figure 19.8b). Cuckoo ray length-distribution in 2019 remained similar to the last decade (Figure 19.8c).

Based on this survey indicator a predicted advice for 2021 and 2022 was given. However, this year the advice was given as catch advice instead of landings advice which was done in previous assessments (issue 2018). This is due to the ADG recommendation of including discard data when this information is available and reliable. Data on discards were available for this stock since 2015 and although variable, it is considered reliable and thus has been included in the assessments. For this reason, there has been a shift from landings to catch advice in this stock. Previous landings advice for 2019 and 2020 was 26 t. This year the recommended catch advice for 2021 and 2022 is 42 t which correspond to landings advice of 31 t.

19.9.4.1 Exploratory length-based indicators

An explanatory assessment using length-based indicators was performed using length-frequency distributions from the Spanish trawl fleet for the years 2016–2019 collected by the onboard observation programme (DCF programme). Landings of the trawl fleet represent the 85% of total landings for the Spanish fleet in this area. The assessment used the eight indicator ratios recommended by WKLIFE (ICES, 2015b) and combined catch data from bottom trawls and trammel nets raised to the corresponding fleets. The reference indicator ratio $L_{mean}/L_{F=M}$ (mean length of individuals larger than the length at first capture over the theoretical average length resulting from exploitation with a fishing mortality equal to natural mortality, which is a proxy for F_{MSY}) suggested that the stock was sustainable exploited (values of 1.00 and close to 0.97 and 0.99). More information in the stock annex.

19.9.5 Cuckoo ray (*Leucoraja naevus*) in Division 9.a (west of Galicia, Portugal, and Gulf of Cadiz) (rjn.27.9a)

The status of this stock is evaluated based on survey data from the Spanish ARSA surveys in Gulf of Cadiz (Q1 SP-GCGFS and Q4 SP-GCGFS).

Both ARSA surveys series indicate a long-term increasing trend, with the highest records of abundance and biomass in 2017 and 2018 (Figure 19.12a–b).

The ratio between the mean biomass index for the last two years (2018–2019) and the mean biomass index for the reference period (2013–2017) was 1.32. The existence of a consistent increasing trend was confirmed by applying the Mann-Kendall trend test to the last 10 years of time series (tau = 0.6, p-value = 0.02).

Although not used in the assessment, due to some missing values in recent years (2004, 2010, 2012, and 2019), the data series from the NepS (FU 28–29) also indicates an overall stable trend (figures 19.11b–c).

Discards from the Spanish fleet were available for this stock where discards from the Portuguese fleets are considered negligible. Thus, following ADG recommendations, discards were included in the assessments for this stock as well as rjn.27.8c stock. This resulted in a shift from landings to catch advice in this stock this year. Previous landings advice for 2019 and 2020 was 70 tonnes. In 2020, the recommended catch advice for 2021 and 2022 was 120 tonnes which correspond to landings advice of 84 tonnes.

19.9.5.1 Exploratory LPUE

As the PtGFS-WIBTS-Q4, the NepS (FU 28–29) survey was not conducted in recent years (2019–2020) and the continuity of the series is uncertain. And although not used to provide advice for rjn.27.9a, due to the irregularity in the series, it is used as auxiliary information. Considering this, and the fact that the ARSA surveys used currently as basis to provide advice only covers a small part of the stock area, an alternative assessment approach using a standardized commercial LPUE series was explored and presented in the WKSKATE meeting (Serra-Pereira *et al.*, 2020 WD; ICES, 2021b). The method is the same as that used for rjh.27.9a and is described in the stock annex for rjh.27.9a (see also Section 19.9.2.2, LPUE for rjc.27.9a). In brief, it considers the estimated landed weight of the species per trip (fishing effort unit) from the Portuguese polyvalent fleet using nets. Portuguese landings represented, on average, 92% of the total reported landings and the polyvalent fleet represented 67–81% in the last three years for the overall stock. The landed weight per trip is obtained by applying the stepwise statistical methodology described in Figueiredo *et al.* (2020c), in which the vessels are stratified by size and fishing seasonality. Vessels classified in the same *strata* are known to operate similarly in terms of fishing time, size of gear and fishing areas. As for rjc.27.9a, no changes in the fishing areas explored or in the distributional area for this stock were observed over the years. Therefore, it is considered unlikely that LPUE are not reflecting the biomass in the exploited areas. The rationale for adopting the fishing trip as effort unit is explained in Section 19.9.2 of this report (see ICES, 2021b for more details).

Several explanatory variables were investigated as potential candidates and the selection of the best model was done through residual graphical analysis and AIC comparison. Those included in the best GLM model (explained variance = 0.58) were: year, quarter, vessel size, fishing seasonality on skates and rays and fishing gear (trammel nets or gillnets) (Figure 19.4e). Annual standardized estimates of CPUE and the corresponding standard error were determined for a reference condition of the variables included in the model apart from the year level (Figure 19.4f).

So, in order to include the new LPUE series as basis to provide advice for rjn.27.9a in 2022, the method was presented (Serra-Pereira *et al.*, 2020 WD) and evaluated during WKSKATE and peer-reviewed by an external review group, as a recommendation from ICES ACOM (ICES, 2021b). In brief, WKSKATE acknowledged the adequacy of the Portuguese commercial LPUE series to assess the status of this stock and accepted its use for the next advice, due in 2022; the reviewers also recognized the choice made by the group to look at the use of LPUEs as an alternative to surveys and made suggestions for further improvement (see Section 19.9.2 and ICES (2021b) for more details). The main concern from the reviewers about the methodology proposed was the non-inclusion of the zeroes in the analysis. The rationale for choosing this approach is described in detail in ICES (2021b) and in Section 19.9.2 of this report. Additional analysis to justify the choice of not including the zeroes in the model will be presented in 2022.

In 2021, the model was updated (explained variance = 0.56, AIC = 23 589) (Figure 19.4f). The best model selected with the updated dataset included all the variables mentioned for the previous model. The mean annual biomass index (kg/trip) scaled by the overall mean for 2019–2020 was 11% smaller than the observed in the preceding five years. For comparison purposes with the current assessment methodology, the LPUE data series was normalized to the long-term mean and compared with the normalized biomass Index obtained from the NepS (FU 28–29) survey (Figure 19.4f). In general, followed similar trends, although the survey series has gaps in 2010, 2012, 2019 and 2020. Also, to note that the survey index is a screenshot in time during a specific time of the year (Q2) whilst the LPUE series is based on information collected throughout the year, so a lag between the two is to be expected. Also, as cuckoo ray is not very abundant in the surveys, the uncertainty of the estimates is larger than those for the thornback ray; considering that, most of the LPUE estimates are within the range of the CI.

19.9.6 Spotted ray (*Raja montagui*) in Subarea 8 (Bay of Biscay and Cantabrian Sea) (rjm.27.8)

In 2019, the biomass index for *R. montagui* in the Spanish IEO Q4-IBTS survey (1.63 kg/haul) is one the highest recorded in Division 8.c since 2002 (Figure 19.7a). Although in the survey *R. montagui* is very scarce in Division 9.a in the time series, in 8.c has been frequent, specifically in the central area of the Cantabrian Sea.

The ratio between the mean biomass index for the last two years (2018–2019) and the mean biomass index for the reference period (2013–2017) was 1.20.

Some estimates of discards are available only since 2015 but considered to be incomplete and the overall discard rate is considered unknown.

Supporting studies using data from French on-board observations indicate that *R. montagui* is observed in a small proportion of hauls. There have been more records in recent years (Figure 19.15). The reliability of this potential indicator may, however, be undermined by confusion between *R. brachyura* and *R. montagui*.

Raja montagui is caught sporadically in the EVHOE survey, mostly in the north and therefore this survey is not representative for this stock. The species in caught in larger quantities in the Celtic sea Figure 19.13). The occurrence of this species in on-board observations of commercial fishing does not suggest recent change in abundance (Figure 19.15).

19.9.7 Spotted ray (*Raja montagui*) in Division 9.a (west of Galicia, Portugal, and Gulf of Cadiz) (rjm.27.9a)

The status of this stock is currently evaluated using only data from the Portuguese Autumn Groundfish Survey (PtGFS-WIBTS-Q4), which covers most of the spatial distribution of the stock. The biomass and abundance indices have been stable along the time-series, with an increasing trend in 2014–2015 and stable in 2016–2017 (Figure 19.11b). The length distribution was relatively stable along the time-series, with the mean length above the average in 2016 and slightly below the average in 2017 (Figure 19.11c). The ratio between the average biomass index for the last two years (2016–2017) and the average biomass index for the reference period (2011–2015) is 1.32. The PtGFS-WIBTS-Q4 was not conducted in 2012 and 2019. In 2018, the survey had technical problems, and part of the stations were sampled using a commercial trawler and a different fishing net (using FGAV019 instead of NCT). Consequently, and since most of the main spatial distribution of the stock was not sampled with the standard procedure (southwest and south coast) the survey index was not possible to obtain. These two problems combined, resulted in a lack of data for the last 2 years (2018 and 2019) making it impossible to apply the ICES approach to data-limited (category 3) stocks, and the stock was evaluated as category 5. Also, there is still doubts if the PtGFS-WIBTS-Q4 time series will have continuity in the future.

The time-series for *R. montagui* in the ARSA surveys is irregular and with very low catches although a high peak in the biomass and abundance values was observed in 2015 and 2016. There are no records of this species in the Spanish IEO Q4-IBTS survey in Division 9.a over the whole time-series. For these reasons the Spanish surveys are not used in the assessment.

19.9.7.1 Exploratory LPUE

Because of the problems with the PtGFS-WIBTS-Q4 survey data availability in 2018–2020 and uncertain future, an alternative assessment approach using a standardized commercial LPUE series was explored and presented in the WGEF 2020 meeting. The methodology adopted is the one currently in use to provide advice for rjh.27.9a and described in the stock annex for this stock. In brief, it considers the estimated landed weight of the species per trip (fishing effort unit) from the Portuguese polyvalent fleet using nets, which represents more than 80% of the Portuguese landings that on its own accounts for more than 95% of the total landings for the stock. The landed weight per trip is obtained by applying the stepwise statistical methodology described in Figueiredo *et al.* (2020c), in which the vessels are stratified by size and fishing seasonality. Vessels classified in the same *strata* are known to operate similarly in terms of fishing time, size of gear and fishing areas (e.g., smaller vessels tend to operate closer to shore than bigger vessels). As for rjc.27.9a, no changes in the fishing areas explored or in the distributional area for this stock were observed over the years. Therefore, it is considered unlikely that LPUE are not reflecting the biomass in the exploited areas. The rationale for adopting the fishing trip as effort unit is explained in Section 19.9.2 of this report (see ICES, 2021b for more details).

Several explanatory variables were investigated as potential candidates and the selection of the best model was done through residual graphical analysis and AIC comparison. Those included in the best GLM model (explained variance = 0.78, AIC = 148 809) were: year, quarter, landing port, vessel size (“SIZEs”), fishing seasonality on skates and rays (“SAZ”) and fishing gear (trammel nets or gillnets) (Figure 19.4g). Annual standardized estimates of CPUE and the corresponding standard error were determined for a reference condition of the variables included in the model apart from the year level. For comparison purposes with the current assessment methodology, the LPUE data series was normalized to the long-term mean and compared with the normalized biomass Index obtained from the PtGFS-WIBTS-Q4 survey (Figure 19.4h). In general, both time-series followed similar trends, although the survey series has gaps in 2012, 2018 and 2019. Also, to note that the survey index is a screenshot in time during a specific time of the year (Q4) whilst the LPUE series is based on information collected throughout the year, so a lag between the two is to be expected. Also, as spotted ray is not very abundant in the surveys, the uncertainty of the estimates is larger than those for the thornback ray; considering that, most of the LPUE estimates are within the range of the CI.

Considering the period used in the 2018 advice, the ratio between the average biomass index for the last two years (2016–2017) and the average biomass index for the reference period (2011–2015) is 1.20 compared to 1.32 obtained with the biomass survey index, which would result in the same advised landings for 2019 and 2020. Using the LPUE to advise for landings in 2021 and 2022, the ratio between the average biomass index for the last two years (2018–2019) and the average biomass index for the reference period (2013–2017) is 0.87.

It is highlighted that the LPUE series is currently the only data source available to assess the status of rjm.27.9a stock, being also considered a reliable source of information and representative for the stock. So, in order to use the new LPUE series as basis to provide advice for rjm.27.9a in 2022, the method was presented (Serra-Pereira *et al.*, 2020 WD) and evaluated during WKSKATE and peer-reviewed by an external review group, as a recommendation from ICES ACOM (ICES, 2021b). In brief, WKSKATE acknowledged the adequacy of the Portuguese commercial LPUE series to assess the status of this stock and accepted its use for the next advice, due in 2022; the reviewers also recognized the choice made by the group to look at the use of LPUEs as an alternative to surveys and made suggestions for further improvement (see Section 19.9.2

and ICES (2021b) for more details). The main concern from the reviewers about the methodology proposed was the non-inclusion of the zeroes in the analysis. The rationale for choosing this approach is described in detail in ICES (2021b) and in Section 19.9.2 of this report. Additional analysis to justify the choice of not including the zeroes in the model will be presented in 2022.

In 2021, the model was updated (explained variance = 0.75, AIC = 124 958) (Figure 19.4h). The best model selected with the updated dataset included all the variables mentioned for the previous model, except the variable fishing gear. Annual standardized estimates of CPUE and the corresponding standard error were determined for a reference condition of the variables included in the model apart from the year level. The mean annual biomass index (kg/trip) scaled by the overall mean for 2019–2020 was 9% smaller than the observed in the preceding five years.

19.9.7.2 Exploratory length-based indicators

The LBI indicators for rjm.27.9.a caught by the Portuguese polyvalent fleet, which represents around 80% of total landings in Portugal, are presented in Table 19.8b (considering 3 cm length classes). These results were expected as threshold levels are considered inappropriate for elasmobranchs. As discussed in WGEF 2020, the most reliable indicator is the MSY related indicator ($L_{mean}/L_{F=M}$) which suggest that the rjm.27.9.a stock is exploited at sustainable levels. Despite being below the threshold adopted (WKLIFE V), the values in 2018 and 2019 are very close to 1.

19.9.8 Undulate ray (*Raja undulata*) in divisions 8.a-b (Bay of Biscay) (rju.27.8ab)

The EVHOE survey is uninformative for this stock because the distribution of *R. undulata* is more coastal than the area surveyed. Exploratory assessments were presented by Biais *et al*. (2014 WD) and summarized in Section 19.8.2.

As the discard rate for this stock is very high (0.94) in the period 2015–2019 and the advised catches issued in 2018 were 202 tonnes, the latest assessment advised that no more than 13 tonnes should be landed in years 2020–2021. The advised catches and corresponding landings have remained constant since 2018.

Data collected from the French on-board observation programme carried out in application of the EU data collection programme indicated that *R. undulata* is caught in a high proportion of hauls in three métiers. The numbers of observations by métiers catching the species are unbalanced. The main métier catching *R. undulata* was GTR_DEF, and data suggested a steady increase in occurrence until 2014 followed by a stabilization. This is based upon more than 6000 observed hauls (Figure 19.13b). The other three selected métiers have either a high occurrence of the species with a moderate on-board observations sample size (OTB_CEP, OTB_DEF) or a low occurrence and a high total number of observations (GNS_DEF). The proportion of hauls catching the species has increased in OTB_CEP and OTB_DEF in recent years (Figure 19.16).

19.9.9 Undulate ray (*Raja undulata*) in Division 8.c (Cantabrian Sea) (rju.27.8c)

There are no longer-term survey data to assess temporal trends in this stock.

Scientific studies carried out in the eastern parts of Division 8.c have been conducted to characterize the specific composition of the landed skates, the species-specific CPUE and the geographical distribution of the catches (Diez *et al.*, 2014). During the period, 2011–2013, up to 118 trips/hauls of 21 vessels of the trammel net fleet from the nine main ports of the Basque

Country were sampled. *Raja undulata* was the fifth species in quantity caught and made up only 5% of the total skates catches.

Whilst the total estimated ICES landings from 2005–2014 were 0 t, this period covers several years for which species-specific data were not required and then a period for which *R. undulata* could not be landed legally. Following relaxation of the prohibited status in 2015, and allowance for small quantities of bycatch, landings between 5–9 tonnes were reported.

The historical landings data is uninformative and unrepresentative of population levels Partial discards are available in two years since 2015 therefore it is considered very incomplete. According to fishing interviews, this species is locally frequent and distributed in the coastal waters of Division 8.c, although not very abundant in catches. This situation may not have changed over the years.

R. undulata is very scarce in the Spanish IEO Q4-IBTS survey in Division 8.c and usually lower than 0.1 kg $haul^{-1}$ in any year of the series. In 2019, nine individuals of this species, ranging from 38 to 93 cm, were captured between 40 and 84 m deep in the Central and Eastern Cantabrian Sea. This due to the fact this species is distributed mainly out of the surveyed ground, in shallower areas not covered because they are not accessible to the vessel and the gear used.

19.9.10 Undulate ray (*Raja undulata*) in Division 9.a (west of Galicia, Portugal, and Gulf of Cadiz) (rju.27.9a)

Raja undulata is absent in the Spanish IEO Q4-IBTS survey in Division 9.a and rarely caught in the Portuguese demersal survey (PtGFS-WIBTS-Q4).

In 2015, IPMA developed a dedicated project to *R. undulata* – UNDULATA that involved onboard-observations, self-sampling and tagging studies (see ICES, 2020; Figueiredo *et al.*, 2015, WD and Maia *et al.*, 2015, WD for a full acount). The main results of the UNDULATA project was that the estimated median total landed weigth of *R. undulata* ranged from 157 and 271 tonnes during the period 2003–2008 (Table 19.9).

Additionally, under the same project, a mark-recapture study was carried out. A total of 353 specimens were tagged in the area of Sesimbra/Setúbal and 170 in the area of Peniche. Total length of tagged females ranged from 52 to 93 cm and from 57 to 89 cm for males. A total of 37 recaptures were recorded, which represented 10% of the tagged specimens. The maximum recorded travelled distance was 26 km and 75% of the recaptures were located at distances less than 10km from the tagging location. The longer period between tagging and recapture was 313 days and 50% of the tagged specimens were recaptured more than 54 days after the tagging event. The majority of the movements (from tagging locations to recapture locations) were recorded down to 50 m deep and seem to followed the shoreline between Sesimbra and Sines which reinforced the previous knowledge that the species prefers shallow sandy coastal areas.

Within the specimens tagged inside the Sado Estuary (n = 70), only three were recaptured during the Project period. From the recaptured specimens, one female with 85 cm TL tagged in February was recaptured outside the estuary area 142 days after and 10 km away from the tagging location in July. In Portuguese continental waters, the species has a reproductive peak between December and May (Serra-Pereira *et al*. 2015) and estuarine areas are given as possible spawning grounds for the species (Prista *et al*., 2003; Moura *et al*., 2007) which could explain this movement from the estuary to the outside area.

These preliminary results indicate that *R. undulata* do not display wide migration patterns, confirming the species high degree of site fidelity.

Following the opening of a TAC in 2016, data were collected from 2016 following and adapting the procedure developed during the UNDULATA project (Figueiredo *et al.* 2015, WD) in order to estimated landings and the potential stock biomass. Data were reliable from 2017, 2016 being an experimental phase used to stabilize the self-sampling with fishermen.

For 2017, by adapting the procedure developed during the UNDULATA project in 2015 (Figueiredo *et al.* 2015, WD), the potential abundance of *R. undulata* was estimated for different regions off the Portuguese continental waters (Figueiredo *et al.*, 2020b). For estimating *R. undulata* potential abundance the two predictors, depth and bottom sediment, considered to be closely related to the species distribution, were included in the model (Figure 19.19). The potential biomass was estimated by multiplying the abundance estimates by an estimate of the mean individual weight:

Region	Year	Potential total abundance (n)	Area (km_2)	Average potential number per km_2	Potential total estimated weight (t) (n*average weight)
North	2017	236034.2	1525.3	154.7	1426.5
Centre	2017	10772.8	3503.6	3.1	65.1
Southwest	2017	201456.7	2132.9	94.4	1217.5
South	2017	1641420	1330.4	1233.8	9919.9

In 2018, due to late assignment of licenses, the information available was considered insufficient for the adjustment of the statistical model proposed. In 2019, the DGRM introduced a landing control process under which vessels possessing a special fishing license continue to be obliged to provide additional information on their fishing activity related to *R. undulata* captures. Additionally, vessels not possessing the special fishing license were allowed to land a maximum of one specimen per trip and were also obliged to provide additional information on their fishing activity related to *R. undulata* captures. Under this new data collection scenario, information on null catches is no longer available and, therefore, not suitable for adjustment of the statistical model proposed to estimate *R. undulata* potential abundance. As a consequence, nor landings nor the potential abundance could be estimated for years 2018–2020.

A CPUE exploratory analysis was performed through the adjustment of a zero-truncated poisson regression model, which are used to model count data for which the value zero cannot occur and considering a pospoisson distribution. It is important to note that the numbers reported are bycatch highly constrained by very specific legislation on the species fishery and fishermen really tend to avoid areas where they known the species occurr and/or concentrates. Given this it is important to keep in mind that we are modeling the probability of encounter the species given certain variables. The input data used to perform the exploratory analysis was collected under the scope of the *R. undulata* monitoring program between 2016 and 2018. The response variable was the number of specimens caught per fishing haul and the explanatory variables considered were the year and quarter. The results of the zero-truncated Poisson regression analysis on the full model, containing both variables, year (2016–2018) and quarter (1–4) are presented in Table 19.10. The analysis of the explanatory variables coefficients, particularly year levels, show variability along the period but without any clear trend. This suggest that the low levels of exploitation, which are exclusively TAC driven, have had no significant impact on the stock. The plot of the residuals versus fitted values, shows that the mean is around zero across all the fitted levels, indicating there were no strong violations of the underlying assumptions (Figure 19.20). It is important to note that although it is a preliminary exploratory analysis and that the available time-series of fishery data on *R. undulata* is still short, it is considered a reliable source for the monitoring of species stock status in the future. A more detailed data and methodology analysis considering the incorporation of other explanatory variables such as mesh size, substrate type, depth and distance to coast, is taking place.

19.9.11 Blonde ray (*Raja brachyura*) in Division 9.a (west of Galicia, Portugal, and Gulf of Cadiz) (rjh.27.9a)

This is a coastal species with a patchy distribution that is caught infrequently by both Spanish and in Portuguese surveys in Division 9.a (usually lower than 0.1 kg $haul^{-1}$ in any year of the series). Consequently, abundance indices derived from these surveys are not considered indicative of stock status. In this case, the status of the stock is assessed based on fishery-dependent data (landings, effort and length structure).

In 2020, *R. brachyura* standardized CPUE (Figure 19.4i) was updated. The data used comprised the Portuguese polyvalent landing estimates by trip for the Peniche landing port. As detailed in the stock annex, the standardization procedure is done via the adjustment of a GLM model to the matrix data, where the response variable is the blonde ray landed weight by trip. Several explanatory variables were investigated as potential candidates and the selection of the best model was done through residual graphical analysis. Annual estimates of CPUE and the corresponding standard error are determined for a reference condition of the variables included in the model apart from the year level (Figueiredo *et al.* 2020 (WD). Mean annual biomass index (kg/trip) scaled by the overall mean for 2019–2020 (69.42) was more than 20% greater than observed in the preceding five years (43.89).

19.9.11.1 Exploratory Yield per recruit and potential spawning ratio

The yield per recruit (Y/R) and potential spawning ratio (%SPR) curves at long term for different levels of fishing mortality and age of first capture (TC) were estimated using the polyvalent fishing data as described in the Stock Annex.

The actual F ($F_{CURR} = 0.17$) is at a level corresponding to about 30% of the virgin exploitable spawning biomass ($F_{30\%SPR} = 0.15$) indicating that the stock has been exploited at a sustainable fishing rate (Figure 19.17).

19.9.11.2 Exploratory of length-based indicators

The LBI indicator for the polyvalent fleet, which represents the major fraction of total landings of the stock, suggests that rjh.27.9.a is exploited at sustainable levels (Table 19.8c). Despite being below the threshold adopted (WKLIFE V), the values in 2018 and 2019 are very close to 1. These results were expected as threshold levels are considered inappropriate for elasmobranchs. Nevertheless, the results for the MSY related indicator, suggest that rjh.27.9.a is exploited at sustainable levels as most of the values obtained were around 1.

19.9.12 Common skate *Dipturus batis*-complex (blue skate *Dipturus batis* and flapper skate *Dipturus intermedius*) in Subarea 8 and Division 9.a (Bay of Biscay and Atlantic Iberian waters) (rjb.27.89a)

Dipturus batis-complex has been confirmed to comprise two species, the nomenclature have been stabilized in Last *et al.* (2016) the smaller species (the form described as *D. cf. flossada* by Iglésias *et al.*, 2010) is named common blue skate, *Dipturus batis* and the larger species flapper skate, *D. intermedius.*

These species are only caught occasionally in Subarea 8 and might not occur to any degree in Division 9.a.

There are no stock size indicators for the two species. Reported landings are low due to restrictive management measures and do not provide information on stock dynamics. Despite the *Dipturus batis*-complex being prohibited in EU regulations, some individuals were landed occasionally in French and Spanish fish markets in Subarea 8. In France, sampled specimens in fish markets included an adult female *Dipturus intermedius* (200 cm L_T) - a southerly record of the species in recent years; and small individuals of *Dipturus batis* caught at the Glénan archipelago (southern Brittany). As these species are now extirpated from inner shelf areas of their former range, fishermen are not always able to identify them accurately. Available information does not change the perception of the stock status of these species that occur at low levels in this ecoregion.

Differing to other areas, *D. oxyrinchus* was included in 2016 and in 2018 advice for the raj.27.89a and not for rjb.27.89a. It is important to highlight that all landings of the genus *Dipturus* from Portugal in Division 9.a refer to *D. oxyrinchus*, for Spain and France official landings of *D. oxyrinchus* were considered to be correctly identified and all the remaining official landings of the genus *Dipturus* from this ecoregion were allocated to *Dipturus* spp., as species identification problems persist among species of the genus *Dipturus* (Figure 19.18).

In 2021, information about *Dipturus* species were compiled for this ecoregion and discussed under the Tor *"Evaluate available data at species-specific level within the common skate-complex (Dipturus spp.) stock units in order to further increase our understanding of each individual species and their current status"*. See section 26.1 of this report for further details.

19.9.13 Other skates in Subarea 8 and Division 9.a (Bay of Biscay and Atlantic Iberian waters) (raj.27.89a)

Sandy ray *Leucoraja circularis* occurs on the deeper shelf and along the slope of the Bay of Biscay and in minor abundance in Portuguese landings. Minor occurrences of the shagreen ray *Leucoraja fullonica* are also observed to the North of Division 8.a, but this species is largely absent from Division 9.a. Owing to the higher abundance of these two species in the Celtic Seas, the Bay of Biscay may comprise the southern limits of the Celtic Sea stocks.

In divisions 8.a-b, occasional catches of *Raja brachyura* and *Raja microocellata* are found at the coast by artisanal fisheries. These two species are scarce in the historical time-series of the Spanish IEO Q4-IBTS survey in divisions 8.c and 9.a.

All four of these species are caught in too small numbers in the EVHOE survey to calculate reliable population indices.

In Division 9.a, *Raja microocellata*, *Raja miraletus* and *D. oxyrinchus* appear occasionally in landings. The two former species are caught in low numbers in Portuguese surveys.

As mentioned in the previous section, landings allocated to *D. oxyrinchus* were included in this stock.

19.9.14 Summary of the status of skate stocks in the Bay of Biscay and Atlantic Iberian waters

The following table provides a summary of stock status for the main species evaluated in 2020 and using ICES DLS approach.

Species	ICES stock code	ICES DLS Category	Perceived status
Thornback ray *Raja clavata*	rjc.27.8	3	No clear trend in survey indices
	rjc.27.9a	3	The stock size indicator shows an increasing trend since 1999
Cuckoo ray *Leucoraja naevus*	rjn.27.9a	3	The stock size indicator shows an increasing trend since 1998
	rjn .27.8c	3	The stock size indicator has been fluctuating with increasing trend since 2011
Spotted ray *Raja montagui*	rjm.27.8	3	The stock size indicator shows an increasing trend in last two years compared with the five precedents.
	rjm.27.9a	3*	The stock size indicator shows a higher level in recent years than in 2005–2012, but has decreased in 2016-2017.
Undulate ray *Raja undulata*	rju.27.8ab	6	Survey data are not informative for this stock
	rju.27.8c	6	Survey data are not informative for this stock
	rju.27.9a	6	Survey data are not informative for this stock
Blonde ray *Raja brachyura*	rjh.27.9a	3	The stock size indicator shows an increasing trend since 2011.
Common skate *Dipturus batis* complex	rjb.27.89a	6	Available data do not inform on stock dynamics, species composition, catch, or landings. There are currently no robust stock size indicators.
Other skates	raj.27.89a	6	There are insufficient data available to assess these species. The decline in landings is due primarily to the improved species-specific reporting.

*Evaluated as Category 5 due to absence of survey data in 2018–2019.

19.10 Quality of assessments

No full analytic stock assessments have been conducted for skates in Subarea 8 and Division 9.a.

LPUE data for *L. naevus and R. clavata* are available for divisions 8.abd since 2001. Since 2008 LPUE were made available for *R. clavata*, *R. microocellata*, *R. montagui*, *R. undulata* and *R. brachyura* in Division 9.a. The inclusion of the standardized LPUE series in the assessment of *R. clavata, R. montagui* and *L. naevus* in Division 9.a were reviewed by WKSKATE and peer-reviewed by an external review group (ICES; 2021b).

In the most recent years, a lot of effort has been made by the countries involved in the demersal elasmobranch fisheries on this ecoregion to provide species-specific landings of skates. As a result of this improvement in the data, 19 different species have been identified (plus general categories "Rajidae", "Torpedinidae" and "Myliobatidae") from catches in subareas 8 and 9. A summary of the information available of the species-specific landings of skates by country is shown in tables 19.1f and 19.2.

The French DCF programme of on-board observations was used as supporting information to appraise temporal trends in stock abundances. Abundance was assessed by the proportion of fishing operations (trawl haul or net set) with catch (discards, landings or both) of the species in the stock area from 2007–2015. Fishing operations were aggregated by DCF level 5 métiers. The four-top ranking métiers (limited to those with more than 50 sampled hauls) were used to indicate stock status.

As for surveys in other ecoregions, surveys in Subarea 8 and Division 9.a were not specifically designed for elasmobranchs, producing a high frequency of zero-catch data. The fishing gear used and the survey design are not the most appropriate to sample elasmobranchs, especially for species with patchy distributions. Surveys do not cover coastal and estuarine areas, and therefore do not provide indicators for stocks distributed in shallow waters. Nevertheless, for some stocks, surveys provide reliable biomass indices.

Efforts have been made to overcome data limitations in order to standardize the fishery-independent abundance indexes, using as an example the estimates for *R. clavata* data from the autumn survey (PtGFS-WIBTS-Q4) in Division 9.a (Figueiredo and Serra-Pereira, 2013 WD). To deal with the large amount of zero-catches a generalized linear mixed model (GLMM) was fitted to the data, assuming a Tweedie distribution for the observations. One of the main purposes of applying a GLMM was to incorporate in the model variables that could account for differences between years, namely the difference between stations, depths, survey methodology, etc. Some decisions/assumptions had to be taken in order to proceed with the analysis of the data, including the determination of a subset of the available data, which better represent the geographical distribution of the species.

Tagging studies of *R. undulata* have shown that the distribution of this species is discontinuous, confirming the 2013 tagging results and the need to assess the state of the stocks of this species for areas that fit with the limited movements that this species may make. This behaviour may be a benefit for obtaining mark–recapture stock estimate as the one provided for the central part of the Bay of Biscay. Results allow an exploratory analysis including a lot of assumptions. Consequently, it must be regarded as only indicative of the biomass trend.

In Portuguese waters, the coastal distribution of *R. undulata* and its habitat preferences, shallow sandy bottoms (~ down to 50 m) hinders the collection of adequate data from IPMA surveys that allow to inform on stock status. In addition, the small by-catch quota assigned to Portugal is considered insufficient to obtain the complete spatial coverage of the species distribution area and by that estimate its potential abundance using the self-sampling data provided by licensed fishing vessels.

Regarding data needs for future monitoring of the stock, the sampling requirements referred in 2017 are maintained. Those requirements are related to the necessity of the full spatial sampling coverage of the species in Portuguese continental waters. Figure 19.21 presents the sampling spatial requirements for the full coverage.

19.11 Reference points

In 2020, new trials were performed using LBI in some of the Biscay and Iberia skate stocks: *Raja undulata* in divisions 8.a-b, *R. brachyura* in Division 9.a, *R. clavata* in Division 9.a and *R. montagui* in Division 9.a and *L. naevus* in 8.c. (see sections 19.8 and 19.9 for more details or respective stock annexes).

The constraints on the use of LBI to inform on elasmobranch stocks were discussed during the 2020 meeting. Following the WGEF 2020 discussions, the LBI indicator related to MSY was considered to provide valuable information about the stock status.

19.12 Conservation considerations

Initial Red List assessments of North-east Atlantic elasmobranchs were summarized by Gibson *et al.* (2008). In 2015, the European Red List of Marine Fishes was published (Nieto *et al.*, 2015), and relevant listings given below (noting that these are on a Europe-wide scale for each species, and are not stock-based):

Species	IUCN Red List Category
Dipturus batis	Critically Endangered
Rostroraja alba	Critically Endangered
Leucoraja circularis	Endangered
Leucoraja fullonica	Vulnerable
Dipturus oxyrinchus	Near Threatened
Raja brachyura	Near Threatened
Raja clavata	Near Threatened
Raja microocellata	Near Threatened
Raja undulata	Near Threatened
Leucoraja naevus	Least Concern
Raja miraletus	Least Concern
Raja montagui	Least Concern

19.13 Management considerations

A TAC for skates in this region was only introduced in 2009, along with requirements to provide species-specific data for the main commercial species (initially *L. naevus* and *R. clavata* and, since 2013, *R. brachyura*). Consequently, there is only a relatively short time-series of species-specific landings. In the case of Portugal, estimates of species-specific landings based on DCF sampling data are available since 2008.

Landings of *Raja undulata* were not allowed between 2009 and 2014 (inclusive), with a bycatch allowance only established for Subarea 8 since 2015, which was then extended to Division 9.a. in 2016. Consequently, landings data for *Raja undulata* are not indicative of stock status. However, landings and discards data could be indicative of stock status for this species along with several monitoring years according to self-sampling programs (French and Portuguese) in these areas.

Currently, fishery-independent trawl survey data provide the longest time-series of species-specific information. These surveys do not sample all skate species effectively, with more coastal species (e.g. *R. brachyura*, *R. microocellata* and *R. undulata*) not sampled representatively.

The status of more offshore species, such as *L. circularis* and *L. fullonica*, are poorly understood, but these two species may be more common in the adjacent Celtic Seas ecoregion (see Section 18).

Some of the larger-bodied species in this ecoregion are from the genus *Dipturus*, but data are limited for all these species, with some potentially more common further north.

19.13.1 Fishery-science projects to estimate abundance of *Raja undulata* stocks

In 2015, a monitoring plan for *R. undulata* was required by WGEF. This involved the design of a fishery scientific survey (e.g. sentinel fishery) which would function in cooperation with commercial fishermen, in particular small-sized vessels and inshore where the species tend to concentrate. A detailed description of the sentinel fishery regarding main aspects in the sampling plan design and data requirements was presented in ICES WGEF reports 2015 and 2016.

Data requirements are summarized below:

Vessel	Vessel name and registration number Vessel technical characteristics (e.g. LOA, tonnage, power, etc.) Registration port Skipper identity and experience
Trip	Date and time of departure/arrival Fishing port of departure/arrival Observer's Identification
Environment condition	Tidal state, sea conditions (e.g. wave height, wind strength) Water temperature
Gear characteristics	Gear type, state (new, good state) For gillnet and trammel net: length and height in meters, mesh in millimetres, number of net units, length of a net unit sheet For longline: length in meters, number, size and type of hooks, type of bait For trawl, dredge: gear dimensions, mesh size, trawling speed, presence of tickler chains, description of gear
Fishing haul	Operation ID Date/time of gear deployment and retrieval Geographic location of the fishing haul (including set and hauling) Fishing depth Soaking/trawling time
Biological data	From all the target species, data collected should include: Coordinates of the capture location Biometric measurements such as total length (from nose to tip of tail), width (from one wing to the other) and body weight Health status (lively, sluggish or dead) Sex Maturity stage (whenever possible) Collected tissue samples of specimen (if from live fish, in accordance with appropriate animal welfare protocols) Survivorship of discarded individuals If marked, the number of the mark should be recorded

19.13.2 Monitoring of *Raja undulata* captures

In 2016, Council Regulation (EU) 2016/458 of 30 March 2016 amended Regulations (EU) 2015/523 as regards individual TACs for *R. undulata* in ICES Divisions.

The use of these *R. undulata* individual quotas was guided by scientific protocols *"to ensure the continuity of scientific studies and to assess the state of the resource and ensure, in the future, its sustainable exploitation"* (COUNCIL REGULATION (EU) 2016/72 of 22 January 2016). Under this regulation, only vessels possessing a compulsory fishery license were allowed to catch *Raja undulata*. Simultaneously, licensed vessels were obliged to record information on species captured by fishing haul and report it to national agencies (Direction des Pêches Maritimes et de l'Aquaculture, DPMA) of the French Ministry for Agriculture and Fisheries and to the General Directorate for Natural Resources, Safety and Maritime Services (DGRM) in France and Portugal respectively).

Portugal:

Historically, in the Portuguese official landings, *R. undulata* was landed under a generic category that encompasses several skate species. This situation limited the use of Portuguese official landings to evaluate historical landings of the species. Under the UNDULATA Project, historical landings of *R. undulata* for the period of 2003–2008 were estimated. The annual median estimates of *R. undulata* landed in Portugal mainland as well as the interquartile estimates are presented in Table 19.9.

Using fishery information from the small experimental quota set for *Raja undulata* since 2016 in ICES Division 9.a, estimates of the species catches along the continental coast were calculated for 2017. The data consisted of official national polyvalent daily landings for 2017, provided by the DGRM. Trips from vessels that landed *R. undulata* at least once during 2017 were used to create a classification rule. The classification rule was determined to predict the plausibility of *R. undulata* been caught in a fishing trip of a vessel of the polyvalent fleet operating in the Portuguese coast. For this, landings data at trip level and species composition of landings were used as predictors. Species considered were those occurring in more than 25% of the trips.

The analysis was performed for each region (North, Centre, Southwest and South) where the species is likely to concentrate. Also, given the well-known heterogeneity in the polyvalent fleet and the assumption that the catch weight is proportional to the vessel's capacity, vessel size category was considered in the analysis.

Fishery self-sampling data from the Portuguese monitoring plan for *R. undulata* were used to estimate mean caught number and weight for each group of region and vessel size category. Using these estimates, the number of trips with potentially positive catches of *R. undulata* and the total catch in weight per trip were calculated and then summed by region and vessel category (Table 19.11)

In 2021, further work is in progress to estimate the discards of this species which, in line with other fisheries in Europe, are considered to be quite high.

It is important to note that although the available fishery information on *R. undulata* is still short, it is considered a reliable source for the monitoring of species stock status. The role of fishermen in the monitoring process is a key element and they need to be aware of their importance on the process, in particular in providing reliable information. Although some of the weaknesses identified on fishermen's reports still persist, efforts are being made in close collaboration with the sector in order to overcome data deficiencies and improve the general quality of the information reported.

France:

Results are described in more detail in Gadenne (2017 WD).

The data collected during the self-sampling 2016 monitoring program indicate that 64 vessels participated in the protocol out of 125 authorizations issued. A total of 7079 hauls were reported, but only 64% were considered valid for analysis.

In 2016, a total of 41.5 tonnes were landed and discards of 117.7 tonnes were reported. Theese landings and discards were caught by 7 types of fishing gear (GND, GNS, GTR, LL, LLS, OTB, and OTT).

In the list of 26 authorized gears, seven gears were used by vessels participating in the self-sampling, with bottom trawls (OTB) and trammel nets (GTR) being predominant. Considering the average weight caught by fishing haul, nets (trammel and gillnets) and longlines appear to be the most suitable gears for catching undulate ray. However, longlines showed a higher rate of discards (85%), followed by trawls (~76%).

Data indicate that the species by-catch mainly occur in coastal areas of the Bay of Biscay. The monthly evolution of catches raises questions about high catch rates in the first months of the year compared to the rest of the self-sampling period. Following the protocol carefully and consistently over time is an essential condition to validate the trends observed.

In conclusion, the main benefit of this self-sampling program is the possibility of quantifying landings, discards and fishing effort for the species, which are crucial for proper stock evaluation and management.

This French self-sampling programme ended in 2019, thereafter it has no longer been required to possess a special licence to land undulate ray.

Spain:

The results from the DCF pilot study held from 2011–2013 and conducted in the Basque Country waters (Division 8.c) with the objective of describing and characterizing coastal artisanal fisheries (trammel nets targeting mainly hake, anglerfish and mackerel), showed that several skate species are caught as bycatch and *Raja undulata* was the fifth most important species caught reaching only the 5% of the total catches (Diez *et al.*, 2014 WD),

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Table 19.1a. Skates in the Bay of Biscay and Iberian Waters. Nominal landings (t) of skates by division and country (Source: ICES). Total landings (t) of Rajidae in divisions 8.a-b.

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Belgium	12	15	9	9	12	4	9	4	6	8	5	4	3	1	2	2
France	2405	1960	1884	1799	1693	1461	1294	1202	1179	1349	1541	1220	1322	1463	1200	1043
Netherlands					0											
Spain*	422	332	373	352	275	163	228	113	242	243	212	262	210	256	213	170
UK	10	40	7	4	0	0	1	2	0		0	0	0	0		
Ireland											35	28				
Norway**		15	4													
Total	2850	2364	2312	2239	2000	1656	1551	1443	1427	1601	1811	1514	1534	1720	1415	1216

*** Includes 8.d (2005–2012, 2015–2016); ** Includes 8.c.**

Table 19.1b. Skates in the Bay of Biscay and Iberian Waters. Total landings (t) of Rajidae in Division 8.d.

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
France	110	63	71	94	72	68	71	76	57	66	61	44	32	46	41	49
Spain	16	12	17	9	0	1	4	2	8	6	6		0	1	0	2
UK	0	3	1	0	0	0	1	0	0	0						
Ireland				0				0			0					
Total	127	77	89	103	72	69	75	78	66	72	66	44	32	47	41	51

Table 19.1c. Skates in the Bay of Biscay and Iberian Waters. Total landings (t) of Rajidae in Division 8.c.

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
France	1	0	1	0	0	0	1	1	0	2	0	0	0	0	0	0
Spain**	177	194	420	433	533	551	663	654	608	528	344	388	377	541	525	450
Total	178	194	421	433	533	552	663	655	608	530	344	388	377	542	525	450

**** Includes 8.e (2015–2016)**

Table 19.1d. Skates in the Bay of Biscay and Iberian Waters. Total landings (t) of Rajidae in Division 9.a.

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
France					1						0		0	0		
Portugal	1303	1544	1444	1439	1444	1454	1425	1122	1104	1026	1012	1026	1138	1105	1133	1227
Spain	301	283	139	134	276	409	429	468	481	455	253	304	348	381	436	430
Ireland					0											
Total	1604	1827	1583	1573	1722	1863	1853	1590	1585	1481	1265	1330	1487	1485	1569	1656

Table 19.1e. Skates in the Bay of Biscay and Iberian Waters. Combined Landings (t) of Rajidae in Biscay and Iberian Waters.

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Belgium	12	15	9	9	12	4	9	4	6	8	5	4	3	1	2	2
France	2517	2023	1955	1893	1766	1529	1367	1279	1236	1418	1602	1264	1354	1510	1242	1092
Netherlands					0											
Portugal	1303	1544	1444	1439	1444	1454	1425	1122	1104	1026	1012	1026	1138	1105	1133	1227
Spain	918	823	985	1004	1104	1152	1342	1359	1339	1233	835	973	935	1179	1173	1052
UK	10	43	8	4	1	0	1	2	0	0	19	0	0	0		
Ireland				0	0			0			35	28				
Norway		15	4													
Total	4760	4462	4405	4349	4327	4140	4144	3766	3686	3685	3507	3296	3430	3795	3550	3373

Table 19.1f. Skates in the Bay of Biscay and Iberian Waters. Combined Landings (t) of Rajidae in Biscay and Iberian Waters (included Division 8e). Landings by ICES stock and country since 2005. Totals by country are presented in bold.

Country	ICES Stock code	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Belgium		**12**	**15**	**9**	**9**	**12**	**4**	**9**	**4**	**6**	**8**	**5**	**4**	**3**	**1**	**2**	**2**
	raj.27.89a	12	15	9	1	2	1	2	0	1	0	1	0	0	0	0	0
	rjc.27.8				2	2	1	2	2	3	3	1	2	1	1	1	1
	rjh.27.9a													0			
	rjm.27.8				0	0	0	0	0					0	0		
	rjn.27.678abd				6	8	3	4	2	3	5	3	2	1	1	1	1
France		**2517**	**2023**	**1955**	**1893**	**1766**	**1529**	**1367**	**1279**	**1236**	**1418**	**1602**	**1264**	**1354**	**1510**	**1242**	**1092**
	raj.27.89a	783	662	610	613	391	244	175	151	179	238	202	181	243	255	16	20
	rja.27.nea	1		0	0	3	0	1	1	0	1	3	1	0			
	rjb.27.89a	11	5	3	5	0	0	0	0	0	0	0	0	0	0		
	rjc.27.8	276	300	215	187	195	217	178	179	194	202	212	166	191	229	223	226
	rjc.27.9a													0	0		
	rjh.27.9a													0	0		
	rjm.27.8	155	130	124	106	64	86	91	86	109	121	149	132	153	172	222	188
	rjm.27.9a													0	0		
	rjn.27.678abd	1290	927	1002	981	1109	980	920	859	754	848	1025	769	745	837	758	636
	rjn.27.8c	0	0		0	0	0	0	0	0	2	0	0	0	0		0
	rjn.27.9a											0		0	0		
	rju.27.8ab	1	0		0	3	2	2	3	0	7	11	14	22	17	23	22
	rju.27.8c													0	0		
	rju.27.9a													0	0		
UK		**10**	**43**	**8**	**4**	**1**	**0**	**1**	**2**	**0**	**0**	**19**	**0**	**0**	**0**		
	raj.27.89a	10	43	8	2	0	0		0	0		1					

Country	ICES Stock code	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
	rjb.27.89a										**0**						
	rjc.27.8							1	2			17	0	0	0		
	rjm.27.8				1	1	0	0				1	0				
	rjn.27.678abd							0				0					
Ireland					**0**	**0**			**0**			**35**	**28**				
	raj.27.89a											4	5				
	rjb.27.89a				0	0						413	15				
	rjc.27.8								0			4	7				
	rjm.27.8											12	1				
	rjn.27.678abd											2	1				
Portugal		**1303**	**1544**	**1444**	**1439**	**1444**	**1454**	**1425**	**1122**	**1104**	**1026**	**1012**	**1026**	**1138**	**1105**	**1133**	**1227**
	raj.27.89a	104	123	38	307	308	293	276	240	144	132	113	99	116	142	120	121
	rja.27.nea	5	6														
	rjc.27.9a	480	569	472	745	739	611	811	570	643	585	578	559	620	654	621	670
	rjh.27.9a	495	586	459	193	163	221	161	165	179	174	236	221	235	191	255	335
	rjm.27.9a	76	90	119	144	184	275	121	108	111	101	67	68	94	57	82	58
	rjn.27.9a	43	51	79	50	50	55	56	39	27	34	20	57	39	23	31	19
	rju.27.9a	100	119	277									23	35	38	25	24
Spain		**918**	**823**	**985**	**1005**	**1104**	**1152**	**1342**	**1359**	**1340**	**1233**	**835**	**973**	**935**	**1179**	**1173**	**1052**
	raj.27.89a	918	823	985	1000	707	627	840	762	616	461	299	367	396	422	433	346
	rjb.27.89a	0		0	1												
	rjc.27.8		0	0	4	136	214	243	268	286	284	183	198	176	300	290	296
	rjc.27.9a					29	115	139	194	166	215	120	123	124	152	181	178
	rjh.27.9a					1	2	1	0	3	0	0	1	0	4	8	12
	rjm.27.8					11	26	22	19	28	40	28	26	27	44	45	42

Country	ICES Stock code	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
	rjm.27.9a			0		7	10	3	2	4	2	1	5	5	5	9	12
	rjn.27.678abd					193	119	59	74	203	204	184	225	169	205	165	125
	rjn.27.8c					18	34	24	26	33	27	15	13	15	23	13	9
	rjn.27.9a					3	4	12	13	2	0	0	1	2	2	8	4
	rju.27.8ab															0	0
	rju.27.8c											5	7	8	9	8	7
	rju.27.9a												8	12	15	13	21
Total general		**4760**	**4462**	**4405**	**4350**	**4327**	**4140**	**4144**	**3766**	**3686**	**3685**	**3508**	**3296**	**3430**	**3795**	**3550**	**3373**

Table 19.2a. Skates in the Bay of Biscay and Iberian Waters. Species-specific landings (in t) in divisions 8.abde since 2005. Last table includes landings of Skates (*Myliobatis* spp, Dasyatidae, *Rhinobatos* spp, Torpedinidae, Gymnuridae) in the same period.

8.abde	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Dipturus oxyrinchus	12	10	2	3	1	6	6	0	0	0	0	0	0			
Dipturus spp	11	5	3	5	0	0	0	0	0	0	13	15	0			
Leucoraja circularis	84	53	58	69	20	28	16	20	20	25	24	22	0		1	1
Leucoraja fullonica	14	8	7	7	45	37	36	30	30	38	47	40	27			
Leucoraja naevus	1290	927	1002	987	1310	1102	983	935	959	1057	1214	996	915	1043	923	761
Raja brachyura				0	11	11	18	7	27	67	65	76	144		5	7
Raja clavata	276	300	215	190	239	246	217	227	244	241	266	211	232	273	266	266
Raja microocellata	0	0	0	1	3	2	4	13	20	38	21	30	54			
Raja montagui	155	130	124	107	65	86	92	86	109	121	162	133	153	172	222	188
Raja undulata	1	0		0	3	2	2	3	0	7	11	14	22	17	23	22
Rajiformes	1135	993	986	974	373	206	252	199	83	79	52	19	18	263	17	20
Rostroraja alba	1		0	0	3	0	1	1	0	1	3	1	0	0		
Rajella fyllae									0							
Total	2979	2426	2398	2343	2072	1725	1627	1520	1493	1673	1878	1558	1566	1768	1456	1267

Table 19.2a cont. Skates in the Bay of Biscay and Iberian Waters. Species-specific landings (in t) in division 8.c since 2005. Last table includes landings of Skates (*Myliobatis* spp, Dasyatidae, *Rhinobatos* spp, Torpedinidae, Gimnuridade) in the same period.

8.c	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Dipturus oxyrinchus											3	0				
Dipturus spp.																0
Leucoraja circularis		0		4	1	2	1	1	1	0	0	0				0
Leucoraja fullonica		0		0	0					0			0			0
Leucoraja naevus	0	0		0	18	34	24	27	33	29	16	13	15	23	13	9
Raja brachyura					0	5	1	0	0	0	1	1	0		2	2
Raja clavata	0	0	0	4	94	186	206	224	238	248	150	161	136	256	247	257
Raja microocellata													0		1	0
Raja montagui					11	25	22	19	28	40	28	26	27	44	45	42
Raja undulata											5	7	8	9	8	7
Rajiformes	178	209	424	426	409	299	409	385	308	213	162	199	190	210	209	132
Total	178	209	424	434	533	552	663	655	609	530	364	408	377	542	525	450

Table 19.2a cont. Skates in the Bay of Biscay and Iberian Waters. Species-specific landings (in t) in division 9.a since 2005. Last table includes landings of Skates (*Myliobatis* spp, Dasyatidae, *Rhinobatos* spp, Torpedinidae, Gimnuridade) in the same period.

9.a	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Dipturus oxyrinchus				72	75	20	68	24	63	33	74	26	41	56	36	16
Dipturus spp.													0			
Leucoraja circularis	0	0	0	1	2	11	1	0	0	0	0	2	1	0	5	5
Leucoraja fullonica								0			0				0	0
Leucoraja naevus	43	51	79	50	53	59	68	53	29	34	20	59	41	25	38	23
Raja brachyura	495	586	459	193	164	223	162	165	182	174	236	222	236	195	263	347
Raja clavata	480	569	472	745	768	725	950	764	809	800	697	682	744	806	802	848
Raja microocellata	88	105	35	19	45	43	29	36	41	45	32	63	68	82	77	91
Raja miraletus	16	19		4	2	6	5	5	1	2	0	2	0	0	0	0
Raja montagui	76	90	119	144	191	284	124	110	115	103	68	73	99	62	90	69
Raja undulata	100	119	277									31	46	52	38	45
Rajiformes	301	283	142	345	421	491	447	432	345	289	139	171	210	207	218	212
Rostroraja alba	5	6														
Total	1604	1827	1583	1573	1722	1863	1853	1590	1585	1481	1265	1330	1487	1485	1569	1656

Table 19.2a cont. Skates in the Bay of Biscay and Iberian Waters. Species-specific landings (in t) in divisions 8.abde, 8.c and 9.a since 2005. Last table includes landings of Skates (*Myliobatis* spp, Dasyatidae, *Rhinobatos* spp, Torpedinidae, Gimnuridade) in the same period.

89.a	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Dasyatidae	1	2	0	0	0	0	0	0	0	0		0	0	0		2
Dasyatis centroura	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0
Dasyatis pastinaca	4	3	6	5	3	3	2	2	3	5	6	4				
Dasyatis spp.															0	0
Gymnura altavela	5	9	12	7	7	7	10	8	12	7	9	10	12	6	4	3
Myliobatidae														43	6	7
Myliobatis aquila	2	2	1	2	1	1	2	1	1	2	2	2	23	15	11	7
Pteroplatytrygon violacea					0			1								
Rhinobatos spp	0	0	0	0	0		0	0	0	0	0	0		0	0	0
Torpedinidae												16	18	18	16	2
Torpedo marmorata	27	24	25	28	25	22	20	20	23	14	18	16				22
Torpedinidae	39	49	45	46	39	50	54	39	43	46	43	33	45	32	30	32
Total	79	89	89	87	76	84	90	72	83	75	78	81	98	114	67	75

Table 19.2b. Skates in the Bay of Biscay and Iberian Waters Other skates and rays in Subareas 8 and Division 9.a. ICES estimates of landings by species and year (in tonnes).

Species	Fishing Area	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Dipturus oxyrinchus	27.8.a	11	2	1	3	0	5	6	0	0	0	0	0	0			
	27.8.b	0	6	0	0				0					0			
	27.8.c								0	0	0	3	0				
	27.8.d	1	1	1	0		0	0	0	0	0	0	0	0			
	27.9.a				72	75	20	68	24	64	33	74	26	41	56	36	16
Leucoraja circularis	27.8.a	72	48	52	59	18	22	14	17	15	20	21	16	0		1	1
	27.8.abd												2				
	27.8.b	2	1	1	0	0	3	1	1	2	1	1	2				0
	27.8.c		0		4	1	2	1	1	1	0	0	0				0
	27.8.d	10	4	6	10	2	3	2	2	3	4	2	2				
	27.8.e	0															
	27.9.a	0	0	0	1	2	11	1	0	0	0	0	2	1	0	5	5
Leucoraja fullonica	27.8.a	12	7	6	6	41	33	32	28	23	30	35	32	25			
	27.8.abd											5	4				
	27.8.b	1	1	0	0	0	1	1	0	5	5	5	3	1			
	27.8.c		0		0	0					0			0			0
	27.8.d	1	1	1	1	4	3	3	2	2	3	2	2	2			
	27.8.e				0												
	27.9.a								0			0				0	0

Species	Fishing Area	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Leucoraja naevus	27.8.a	1191	865	940	903	983	912	880	806	705	783	977	791	755	879	752	598
	27.8.abd					2	13		12			2	1				
	27.8.b	13	14	9	11	267	119	43	51	199	211	174	165	133	124	132	120
	27.8.c	0	0		0	18	34	24	27	33	29	15	13	15	23	13	9
	27.8.ce											0	0				
	27.8.d	87	48	54	73	59	58	59	66	56	63	55	39	27	40	39	41
	27.8.d.2											5			1		1
	27.8.e		0		0	0	0	0									
	27.9.a	43	51	79	50	53	59	68	53	29	34	20	59	41	25	38	23
Raja brachyura	27.8.a				0	8	7	4	6	25	63	63	75	142		5	7
	27.8.abd											0					
	27.8.b				0	3	4	14	1	2	4	2	1	2			
	27.8.c					0	5	1	0	0	0	1	1	0		2	2
	27.8.d					0	0	1	0	0	0	0	0				
	27.8.e								0			0					
	27.9.a	495	586	459	193	164	223	162	165	182	174	236	222	236	195	263	347
Raja clavata	27.8.a	245	246	172	152	141	159	112	100	95	100	127	99	124	170	169	164
	27.8.abd					1	1	0	25			20	7				
	27.8.b	29	52	42	36	93	84	99	96	147	138	117	106	107	102	95	96
	27.8.c	0	0	0	4	94	186	206	224	238	248	146	154	136	256	247	257
	27.8.ce											3	7				
	27.8.d	3	1	1	2	3	2	5	6	3	2	1	1	1	1	2	6
	27.8.d.2											0		0	0		0
	27.8.e	0	0		0	0	0	1			0	0					
	27.9.a	480	569	472	745	768	725	950	764	809	800	697	682	744	806	802	848

Species	Fishing Area	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Raja microocellata	27.8.a	0	0	0	0	2	1	1	2	6	12	12	15	37			
	27.8.b	0	0		0	0	0	3	11	14	25	9	15	17			
	27.8.c													0		1	0
	27.8.d			0	0	1	0		0	0	0	0	0	0			
	27.9.a	88	105	35	19	45	43	29	36	41	45	32	63	68	82	77	91
Raja miraletus	27.9.a	16	19		4	2	6	5	5	1	2	0	2	0	0	0	0
Raja montagui	27.8.a	104	78	78	65	59	74	86	85	105	119	147	131	151	170	220	185
	27.8.abd											13	1				
	27.8.b	49	51	46	41	6	12	4	1	3	2	2	2	2	1	1	1
	27.8.c					11	25	22	19	28	40	27	25	27	44	45	42
	27.8.ce											0	0				
	27.8.d	2	0	0	1	0	1	1	0	0	0	0	0	0	0	0	2
	27.8.e				0	0	0	0	0				0				
	27.9.a	76	90	119	144	191	284	124	110	115	103	68	73	99	62	90	69
Raja undulata	27.8.a					0	1	0	0	0	2	8	8	16	13	16	16
	27.8.b	1	0		0	3	1	2	2	0	5	3	6	6	4	6	6
	27.8.c											5	7	8	9	8	7
	27.9.a	100	119	277									31	46	52	38	45
Rajella fyllae	27.8.b									0							

Species	Fishing Area	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Rajiformes	27.8.a	562	537	535	474	160	144	122	68	63	54	38	9	4	233	4	6
	27.8.abd	1	2	36	76	16	14	19	85								
	27.8.b	548	434	388	408	194	46	107	44	18	25	14	10	12	24	12	14
	27.8.bc		15	4													
	27.8.c	178	194	420	426	409	299	409	385	308	213	149	187	190	210	209	132
	27.8.ce											13	12				
	27.8.d	22	21	27	16	3	3	5	1	1	1	0	0	2	6	0	0
	27.8.d.2											0					0
	27.8.e	2		0	0	0					0	0		0	0		
	27.9.a	301	283	142	345	421	491	447	432	345	289	139	171	210	207	218	212
	27.9.b											0					
TOTAL		**4749**	**4458**	**4402**	**4344**	**4327**	**4140**	**4144**	**3766**	**3686**	**3685**	**3495**	**3281**	**3430**	**3795**	**3550**	**3373**

Table 19.3a. Skates in the Bay of Biscay and Iberian. Historical discard estimates (t) by country of the different stocks reported to the WGEF.

	raj.27.89a	rjb.27.89a	rjc.27.8	rjc.27.9a	rjh.27.9a	rjm.27.8	rjm.27.9a	rjn.27.678abd	rjn.27.8c	rjn.27.9a	rju.27.8ab	rju.27.8c	rju.27.9a
Belgium			**4**					**1466**					
2013			1					67					
2014			0					42					
2015			0					48					
2016			1					169					
2017			1					859					
2018								34					
2019								131					
2020			2					116					
Spain	**1**	**3**	**352**	**114**	**6**	**55**	**59**	**1244**	**37**	**91**		**1**	**22**
2015		3	78	31	0	1	1	315	11	4		1	0
2016			109	43	2	34	41	315	11	41			7
2017			27	7	0	2	12	128	3	22		0	14
2018			33	13	0	5	2	139	5	16		0	0
2019	1	0	36	21	3	12	3	241	8	7		0	1
2020			70					105					
France	**1595**	**19**	**110**			**219**		**3799**			**1040**		
2016	713		27			71		820			416		
2017	882		24			85		1030			230		
2018		19	22			0		667			271		
2019			10			63		855			122		
2020			27			0		428					
UK								**1593**					
2009								59					
2010								177					

	raj.27.89a	rjb.27.89a	rjc.27.8	rjc.27.9a	rjh.27.9a	rjm.27.8	rjm.27.9a	rjn.27.678abd	rjn.27.8c	rjn.27.9a	rju.27.8ab	rju.27.8c	rju.27.9a
2011								52					
2012								52					
2013								102					
2014								198					
2015								50					
2016								196					
2017								101					
2018								207					
2019								41					
2020								359					
Ireland								**8106**					
2009								857					
2010								1886					
2011								746					
2012								866					
2013								469					
2014								719					
2015								673					
2016								562					
2017								597					
2018								732					
2019								975					
2020								322					
Total	**1595**	**22**	**467**	**114**	**6**	**274**	**59**	**17506**	**37**	**91**	**1040**	**1**	**22**

Table 19.3b. Skates in the Bay of Biscay and Iberian Waters. Estimate of the relationship discards/catches (in percentage) of the *L. naevus* and *R. clavata* by the Basque OTB (Bottom otter trawl) in Divisions 8.abd.

Year	*L. naevus*	*R. clavata*
2009	4%	0%
2010	11%	3%
2011	14%	11%
2012	9%	1%
2013	18%	10%
2014	12%	3%
2015	30%	13%
2016	51%	52%
2017	50%	15%
2018	53%	12%
2019	42%	19%

Table 19.4a. Skates in the Bay of Biscay and Iberian Waters. Percentage of individuals by vitality status after capture (1 = Good; 2 = Moderate; 3 = Poor) in relation to mesh size and soak time in the Portuguese polyvalent fleet operating with trammel nets for *Raja clavata*, *Raja montagui*, *Raja brachyura*, *Leucoraja naevus* and *Raja undulata.* The total length range is also given.

			Vitality status				
Species	**Mesh size (mm)**	**Soak time (h)**	**1**	**2**	**3**	**n**	**TL range (cm)**
Raja clavata	< 180	< 24	100%	0%	0%	17	23-72
		> 24	72%	12%	16%	25	39-80
	> 180	< 24	92%	4%	4%	26	48-88
		> 24	52%	23%	24%	103	40-96
Raja brachyura	< 180	< 24	67%	22%	11%	9	39-66
		> 24	92%	4%	4%	24	27-75
	> 180	< 24	57%	19%	24%	21	49-95
		> 24	70%	20%	10%	143	18-106
Raja montagui	< 180	< 24	100%	0%	0%	18	21-64
		> 24	67%	21%	12%	42	10-60
	> 180	< 24	40%	30%	30%	20	46-62
		> 24	37%	33%	30%	43	37-68
Leucoraja naevus	< 180	< 24	1	-	-	1	53
	> 180	< 24	1	-	-	1	61
		> 24	58%	21%	21%	24	46-62
Raja undulata	< 180	< 24	82%	16%	2%	44	40-89
		> 24	90%	5%	5%	58	43-92
	> 180	< 24	79%	7%	14%	71	32-92
		> 24	96%	1%	3%	174	44-92

Table 19.4b. Skates in the Bay of Biscay and Iberian Waters. Percentage of individuals by vitality status (1 = Excellent; 2 = Good; 3 = Poor; 4 = Dead) of each species assessed onboard IPMA's otter trawl surveys, for different deck times. For n ≤ 5, observed numbers by vitality are shown instead of percentages.

Species	Survey	Deck time	Length class	1	2	3	4	n	TL range (cm)
Raja clavata	PT-CTS	< 108 min	< 52 cm	47%	13%	33%	7%	30	
		< 108 min	> 52 cm	4	-	1	-	5	
		> 108 min	< 52 cm	0%	0%	0%	100%	25	
		> 108 min	> 52 cm	-	1	-	3	4	
	PTGFS-WIBTS-Q4	< 108 min	< 52 cm			1	1	2	
		< 108 min	> 52 cm	26%	46%	23%	6%	35	

Table 19.5. Skates in the Bay of Biscay and Iberian Waters. Relative estimated landed weight (%) for skate species for the Portuguese polyvalent and trawl fleets (2008–2020).

	Polyvalent												
	2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Raja miraletus	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Raja clavata	48%	48%	40%	54%	44%	56%	53%	53%	51%	53%	58%	53%	54%
Raja microocellata	2%	4%	3%	3%	4%	5%	5%	4%	7%	7%	11%	8%	9%
Raja brachyura	15%	11%	16%	13%	18%	19%	20%	27%	25%	22%	17%	22%	28%
Leucoraja circularis	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%
Raja montagui	10%	13%	19%	8%	9%	10%	10%	7%	6%	8%	5%	7%	4%
Leucoraja naevus	2%	3%	3%	3%	3%	2%	3%	1%	5%	2%	1%	3%	1%
Dipturus oxyrinchus	6%	5%	1%	4%	3%	5%	3%	8%	3%	4%	4%	4%	1%
Rajidae	17%	16%	16%	15%	19%	4%	6%	0%	0%	0%	0%	0%	0%
	Trawl												
	2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Raja miraletus	1%	0%	1%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%
Raja clavata	64%	60%	47%	66%	71%	66%	76%	77%	71%	64%	73%	65%	62%
Raja microocellata	0%	0%	2%	0%	0%	0%	2%	0%	3%	1%	0%	0%	0%
Raja brachyura	8%	12%	13%	5%	6%	8%	8%	7%	10%	14%	15%	24%	25%
Leucoraja circularis	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Raja montagui	10%	11%	17%	8%	11%	12%	4%	4%	8%	12%	7%	7%	9%
Leucoraja naevus	7%	6%	8%	8%	6%	4%	5%	5%	7%	8%	5%	3%	2%
Dipturus oxyrinchus	3%	6%	3%	8%	1%	8%	4%	6%	0%	1%	1%	0%	2%
Rajidae	7%	5%	7%	5%	3%	2%	0%	0%	0%	0%	0%	0%	0%

Table 19.6. Skates in the Bay of Biscay and Iberian Waters. LPUE (kg day^{-1}) of the *L. naevus* and R. *clavata* caught by the Basque Country OTB DEF >= 70 and OTB DEF = 100 (Bottom otter trawl) in Subarea 8.

Year	*L. naevus*	*R. clavata*
2001	112	27
2002	91	16
2003	136	19
2004	120	21
2005	134	23
2006	140	24
2007	169	29
2008	137	24
2009	84	18
2010	44	14
2011	115	25
2012	33	21
2013	72	18
2014	79	19
2015	130	28
2016	119	32
2017	58	54
2018	51	41
2019	50	13

Table 19.7. Skates in the Bay of Biscay and Iberian Waters. Life-history information. Biological parameter estimates available for skate species inhabiting Portuguese Iberian waters. Growth models: VBR – von Bertalanffy Growth Model; GG – Gompertz Growth Model.

									Growth parameters estimates								
Species	**TL range (cm)**	**L50 (cm) F**	**L50 (cm) M**	**l50 (years) F**	**l50 (years) M**	**Fecundity**	**Reproductive period**	**Growth model**	**L∞ (cm)**	**k (y–1)**	**t0 (years)**	**Lmax (cm)**	**lmax (years)**	**l∞ longevity (years)**	**Period**	**Region**	**Source**
R. undulata	19.4–88.2	76.2	73.6	8.98	7.66	-	-	VBG	110.2	0.11	–1.58	88.2	13	-	1999–2001	Algarve	[1,2]
	23.7–90.5	83.8	78.1	9	8	-	Feb–May	VBG	113.7	0.15	–0.01	90.5	12	23.6	2003–2006	Centre	[3]
	32.0–83.2	-	-	-	-	-	-	VBG	119.3	0.12	–0.41	83.2	9	28.9	1999–2001	Algarve	[3]
	23.5–95.9	86.2 ±2.6	76.8 ±2.4	8.7 ±0.3	7.6 ±0.4	69.8 ±3.4	Dec–May	-	-	-	-	-	-	-	2003–2013	North /Centre	[4]
R. clavata	14.3–91.3	-	-	-	-		-	VBG	128.0	0.112	–0.62	91.3	10	-	2003–2007	All	[5]
	12.5–105.0	78.4	67.6	7.5	5.8	136	May–Jan		-	-	-	-	-	-	2003–2008	All	[6]
R. brachyura	37.4–106.1	97.9	88.8	-	-	-	Mar–Jul	VBG	110.51	0.12	0.26	106.1	-	-	2003–2004	All	[7]
	37.6–108.8	96.6	88.6	-	-		Mar–Jul		-	-	-	-	-	-	2003–2012	North /Centre	[10]
R. montagui	25.2–76.1	59.4	50.4	-	-	-	Apr–Jun	VBG	75.9	0.23	0.16	76.1	7	-	2003–2004	All	[8]
	36.8–70.2	56.7	48.0	-	-		Apr-Jul	-	-	-	-	-	-	-	2003–2012	All	[10]
L. naevus	12.7–71.8	55.6	56.5	-	-		-	VBG	79.2	0.24	0.12	71.8	-	-	2003–2004	All	[7]
	13.3–71.8	56.5	56.0	-	-	63	Jan-May		-	-	-	-	-	-	2003–2010	All	[9]

[1] Coelho and Erzini, 2002; [2] Coelho and Erzini, 2006; [3] Moura *et al.*, 2008; [4] Serra-Pereira et al., 2015; [5] Serra-Pereira *et al.*, 2008; [6] Serra-Pereira *et al.*, 2011; [7] Farias, 2005; [8] Serra-Pereira, 2005; [9] Maia *et al.*, 2012; [10] Pina Rodrigues, 2012.

Table 19.8a. Results from the combined length distribution of *R. clavata* from the polyvalent fleet, in Portugal mainland (Division 9.a), for multiple years (2008–2019) from the LBI method.

	Conservation				Optimizing Yield	MSY
	L_c/L_{mat}	$L_{25\%}/L_{mat}$	$L_{max5\%}/L_{inf}$	P_{mega}	L_{mean}/L_{opt}	$L_{mean}/L_{F=M}$
Ref	**>1**	**>1**	**>0.8**	**>30%**	**~1**	**≥1**
2008	0.61	0.68	0.66	0.00	0.74	0.93
2009	0.61	0.68	0.67	0.00	0.77	0.97
2010	0.67	0.75	0.67	0.00	0.78	0.93
2011	0.61	0.71	0.69	0.00	0.78	0.99
2012	0.67	0.70	0.68	0.00	0.78	0.93
2013	0.67	0.72	0.69	0.00	0.79	0.95
2014	0.67	0.76	0.70	0.00	0.80	0.96
2015	0.73	0.77	0.72	0.01	0.84	0.95
2016	0.48	0.75	0.71	0.02	0.78	1.11
2017	0.73	0.78	0.70	0.00	0.84	0.95
2018	0.67	0.73	0.72	0.02	0.81	0.97
2019	0.67	0.76	0.72	0.01	0.81	0.97

Table 19.8b. Results from the combined length distribution of *R. montagui* from the polyvalent fleet, in Portugal mainland (Division 9.a), for multiple years (2008–2019) from the LBI method.

	Conservation				Optimizing Yield	MSY
	L_c/L_{mat}	$L_{25\%}/L_{mat}$	$L_{max5\%}/L_{inf}$	P_{mega}	L_{mean}/L_{opt}	$L_{mean}/L_{F=M}$
Ref	**>1**	**>1**	**>0.8**	**>30%**	**~1**	**≥1**
2008	0.66	0.84	0.73	0.02	0.85	1.03
2009	0.87	0.89	0.79	0.08	0.95	0.97
2010	0.87	0.96	0.84	0.32	1.01	1.04
2011	0.56	0.87	0.79	0.05	0.88	1.16
2012	0.87	0.87	0.78	0.04	0.91	0.94
2013	0.56	0.89	0.78	0.04	0.89	1.17
2014	0.93	0.91	0.82	0.07	0.99	0.98
2015	0.66	0.89	0.76	0.04	0.89	1.07
2016	0.61	0.91	0.82	0.11	0.95	1.19
2017	0.56	0.94	0.92	0.12	0.95	1.26
2018	0.98	0.98	0.77	0.03	0.98	0.93
2019	0.82	0.91	0.78	0.09	0.93	0.99

Table 19.8c. Results from the combined length distribution of *R. brachyura* from the polyvalent fleet, in Portugal mainland (Division 9.a), for multiple years (2008–2019) from the LBI method.

	Conservation				Optimizing Yield	MSY
	L_c/L_{mat}	$L_{25\%}/L_{mat}$	$L_{max5\%}/L_{inf}$	P_{mega}	L_{mean}/L_{opt}	$L_{mean}/L_{F=M}$
Ref	**>1**	**>1**	**>0.8**	**>30%**	**~1**	**≥1**
2008	0.57	0.63	0.77	0.06	0.75	0.96
2009	0.63	0.61	0.70	0.01	0.69	0.85
2010	0.57	0.64	0.75	0.04	0.76	0.98
2011	0.63	0.68	0.77	0.08	0.83	1.02
2012	0.39	0.69	0.77	0.05	0.78	1.20
2013	0.63	0.68	0.76	0.05	0.81	0.99
2014	0.57	0.68	0.78	0.07	0.82	1.06
2015	0.63	0.74	0.79	0.12	0.88	1.08
2016	0.69	0.74	0.78	0.08	0.86	0.99
2017	0.69	0.77	0.79	0.09	0.87	1.01
2018	0.69	0.70	0.78	0.07	0.83	0.97
2019	0.69	0.74	0.77	0.07	0.84	0.98

Table 19.9. Skates in the Bay of Biscay and Iberian Waters. Annual estimates of the posterior median, 25% and 97.5% quartiles of the total landed weight of *Raja undulata* for the period 2003–2008 along the Portuguese mainland (Division 9.a)

Year	median	P2.5	P97.5
2003	164.3	137.1	197.0
2004	197.0	164.2	235.8
2005	171.7	141.2	208.4
2006	271.3	232.6	315.1
2007	156.7	132.3	185.6
2008	208.3	178.4	243.4

Table 19.10. Skates in the Bay of Biscay and Iberian Waters. *Raja undulata* CPUE: results of the zero-truncated Poisson regression analysis on the full model, containing both variables, year (2016–2018) and quarter (1–4).

Coefficients:	Estimate	Std. Error	z-value	Pr(>|z|)
(YEAR)2016	2.07573	0.03677	56.45	<2e-16***
(YEAR)2017	1.68566	0.03018	55.85	<2e-16***
(YEAR)2018	2.00571	0.02811	71.34	<2e-16***
(QUARTER)2	0.49734	0.03343	14.88	<2e-16***
(QUARTER)3	0.36449	0.03282	11.11	<2e-16***
(QUARTER)4	0.25755	0.03416	7.54	4.7e-14***

Table 19.11. *Raja undulata* potential catches estimates in Portugal mainland (Division 9.a) by region and vessel size category for 2017. Official landed weight (in ton) in each region is also presented.

Region	Official landed weight (ton)	Vessel size Category	Potential total captured number	Potential total captured weight (ton)
North	14.3	>13	2393	9.2
		<13	3624	12.9
Center	2.0698	>12	167	0.4
		<12	8886	23.3
Southwest	9.1224	>10	299	1.6
		<10	10786	27.9
South	7.2303	>10	675	1.0
		<10	14021	41.2
Total	32.716		40851	117.3

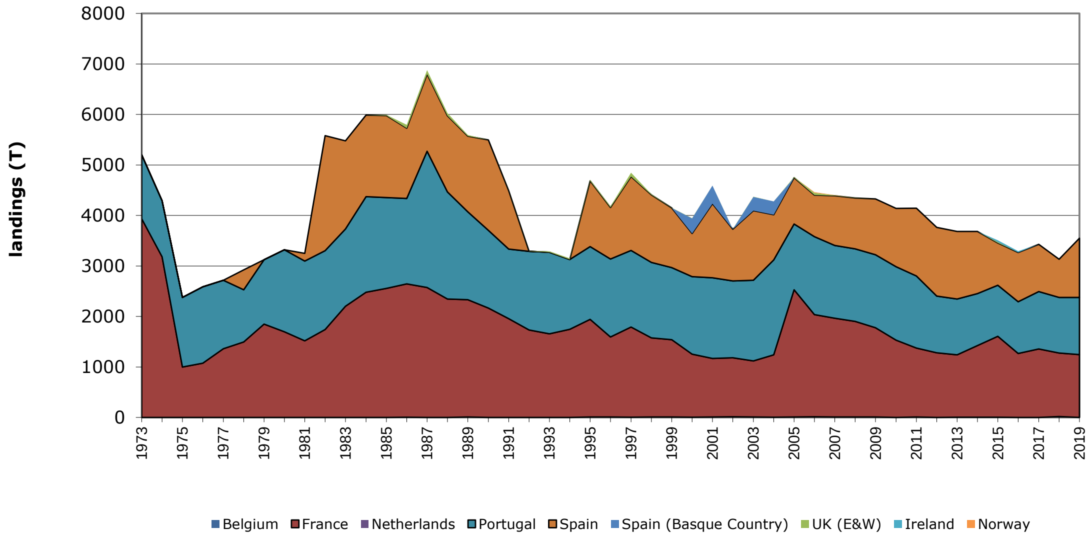


Figure 19.1. Skates in the Bay of Biscay and Iberian Waters. Historical trend in landings of Rajidae in Subarea 8 and Division 9.a since 1973.

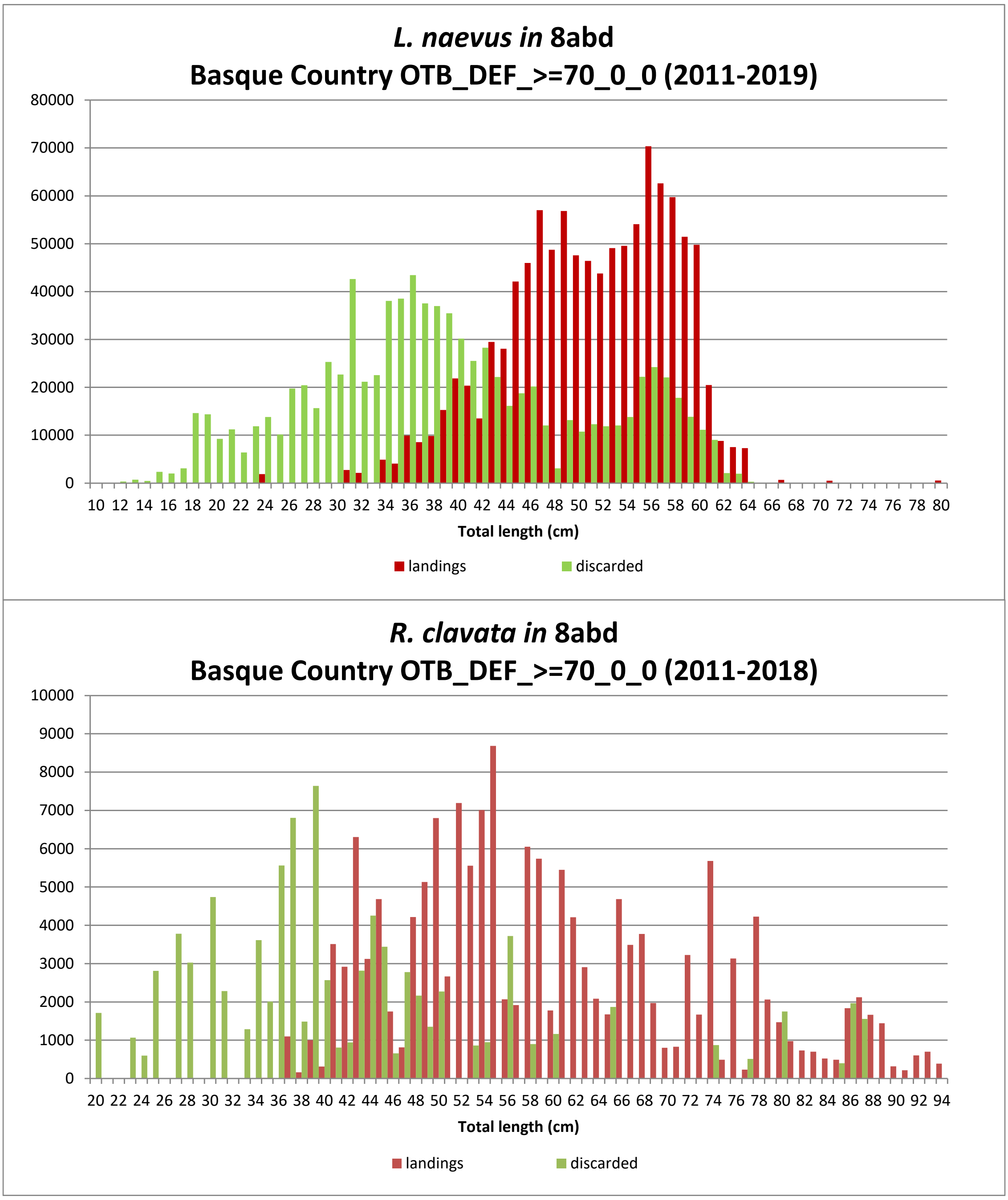


Figure 19.2a. Skates in the Bay of Biscay and Iberian Waters. Length–frequency distribution of the *Leucoraja naevus* and *Raja clavata* for the period from 2011–2019 of the Basque OTB (Bottom Otter Trawler).

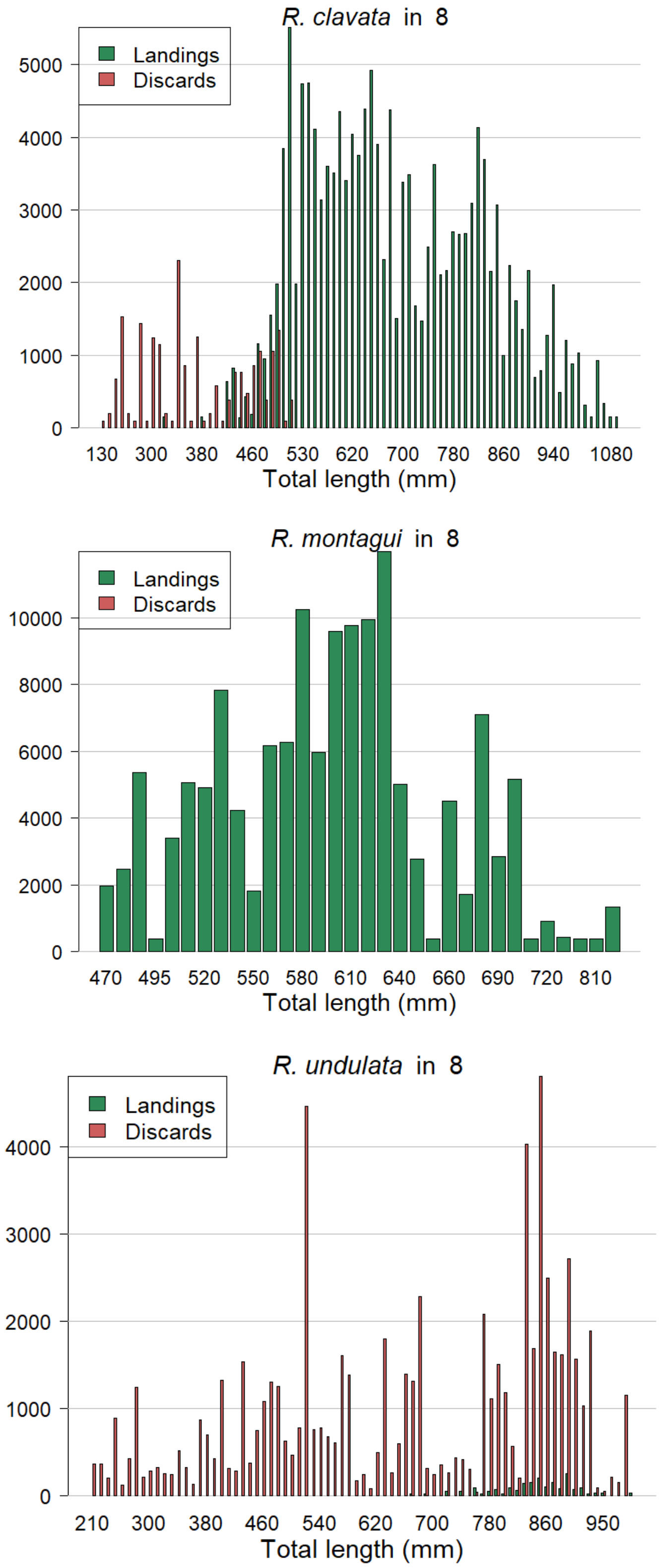


Figure 19.2b. Skates in the Bay of Biscay and Iberian Waters. Length–frequency distribution of *Raja clavata, R. montagui and R. undulata* by the commercial French fleet (bottom trawl and nets) for the period 2016–2020 in Subarea 8.

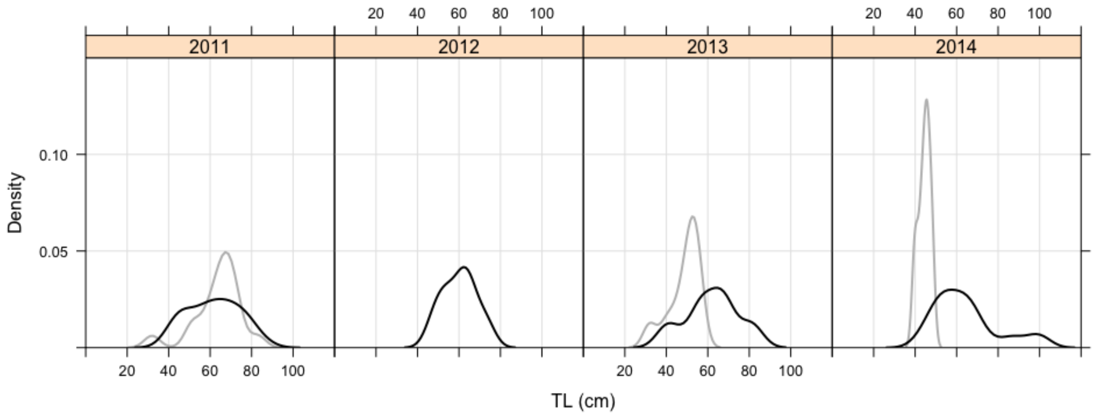


Figure 19.2c. Length frequency distribution of *R. clavata* retained (black) and discarded (grey) fractions observed onboard vessels with LOA >12 m and with fishing permit to operate with gillnets and/or trammel nets, between 2011 and 2014, in mainland Portugal (Division 9.a). The length frequencies were not raised to the total landings. n = 204 sampled individuals.

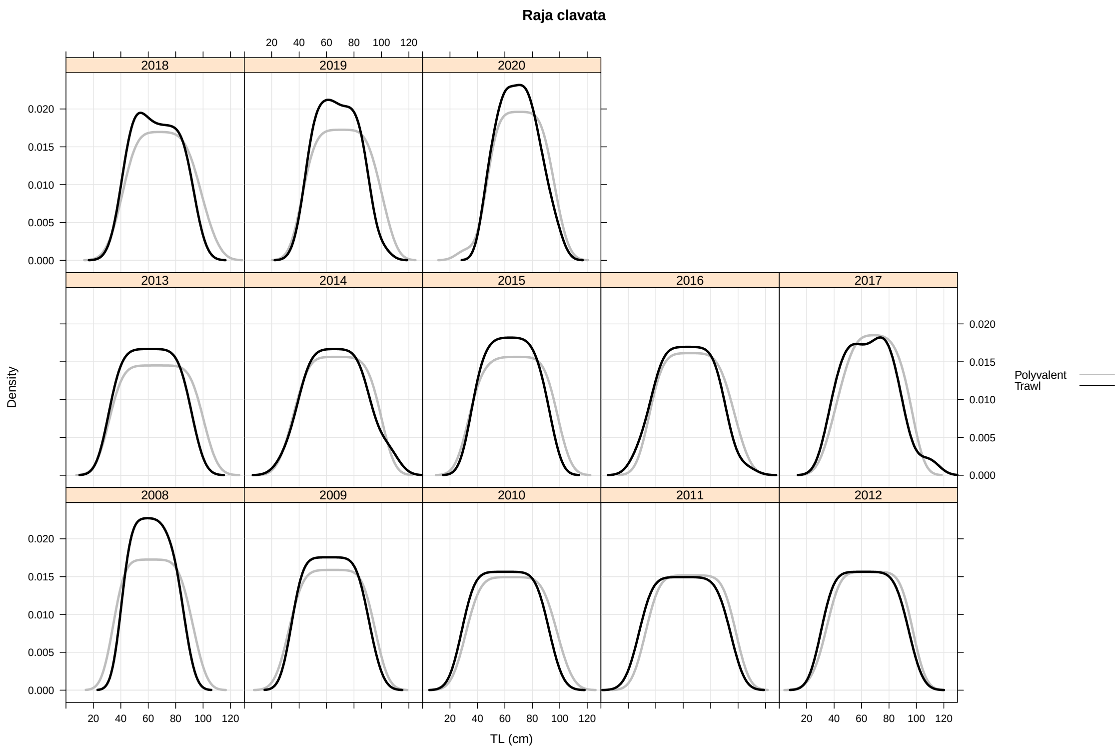


Figure 19.2d. Skates in the Bay of Biscay and Iberian Waters. Length–frequency distribution of *Raja clavata* for the period from 2008–2020 in mainland Portugal (Division 9.a). Total number of sampled trips was n = 2846 for the polyvalent segment and n = 837 for the trawl segment.

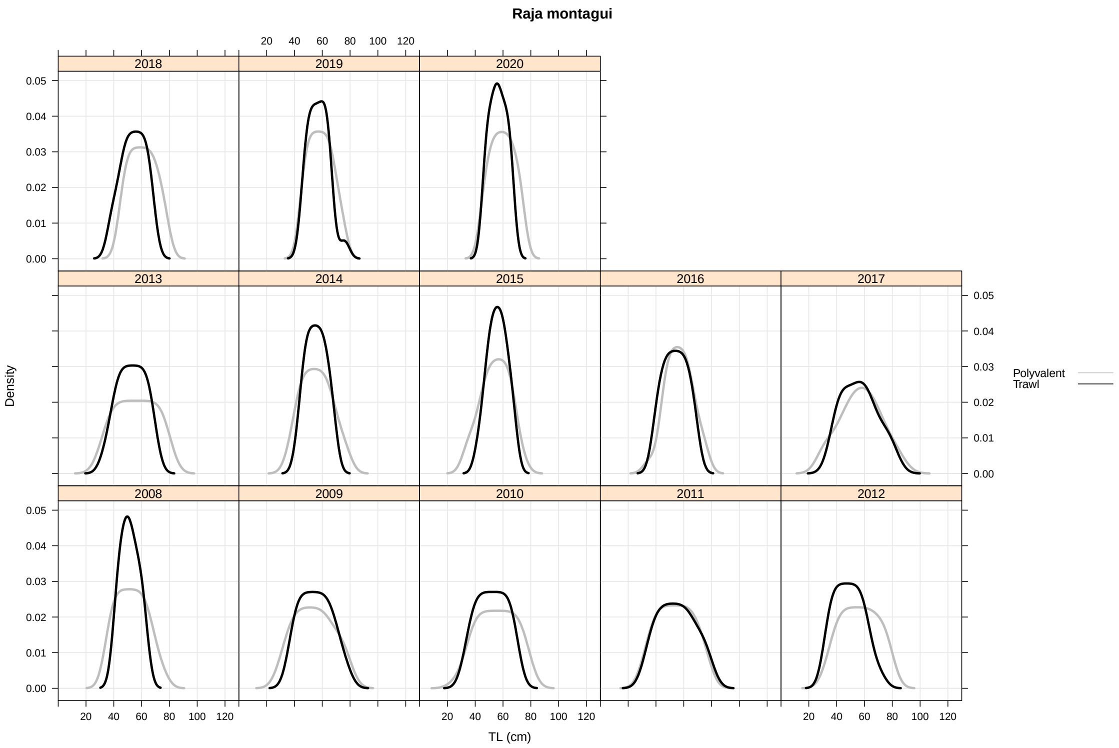


Figure 19.2e. Skates in the Bay of Biscay and Iberian Waters. Length–frequency distribution of *Raja montagui* for the period from 2008–2020 in mainland Portugal (Division 9.a). Total number of sampled trips was n = 1194 for the polyvalent segment and n = 417 for the trawl segment.

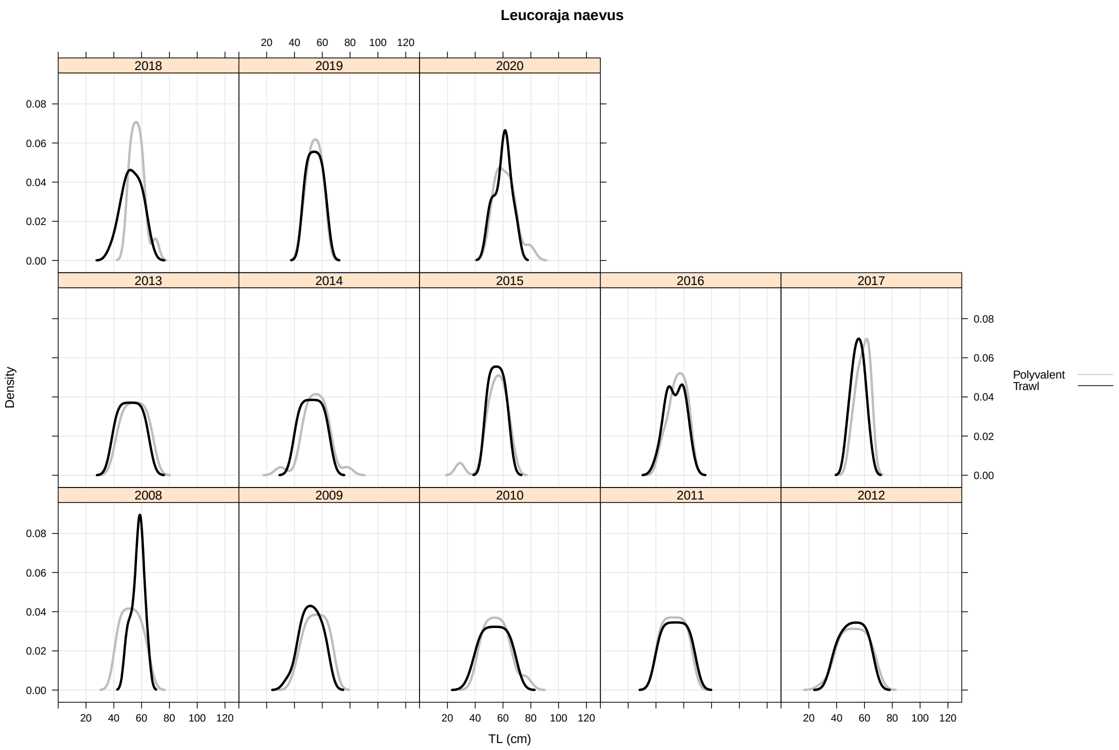


Figure 19.2f. Skates in the Bay of Biscay and Iberian Waters. Length–frequency distribution of *Leucoraja naevus* for the period from 2008–2020 in mainland Portugal (Division 9.a). Total number of sampled trips was n = 317 for the polyvalent segment and n = 191 for the trawl segment.

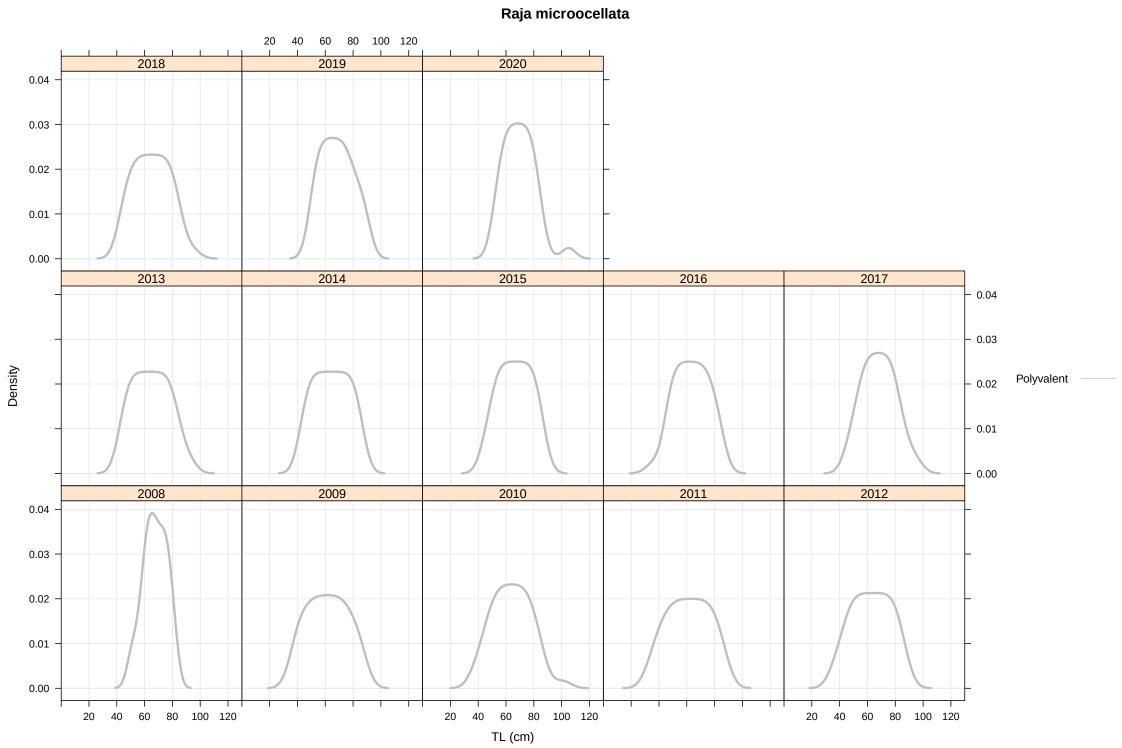


Figure 19.2g. Skates in the Bay of Biscay and Iberian Waters. Length–frequency distribution of *Raja microocellata* for the period from 2008–2020 in mainland Portugal (Division 9.a). Total number of sampled trips was n = 763 for the polyvalent segment.

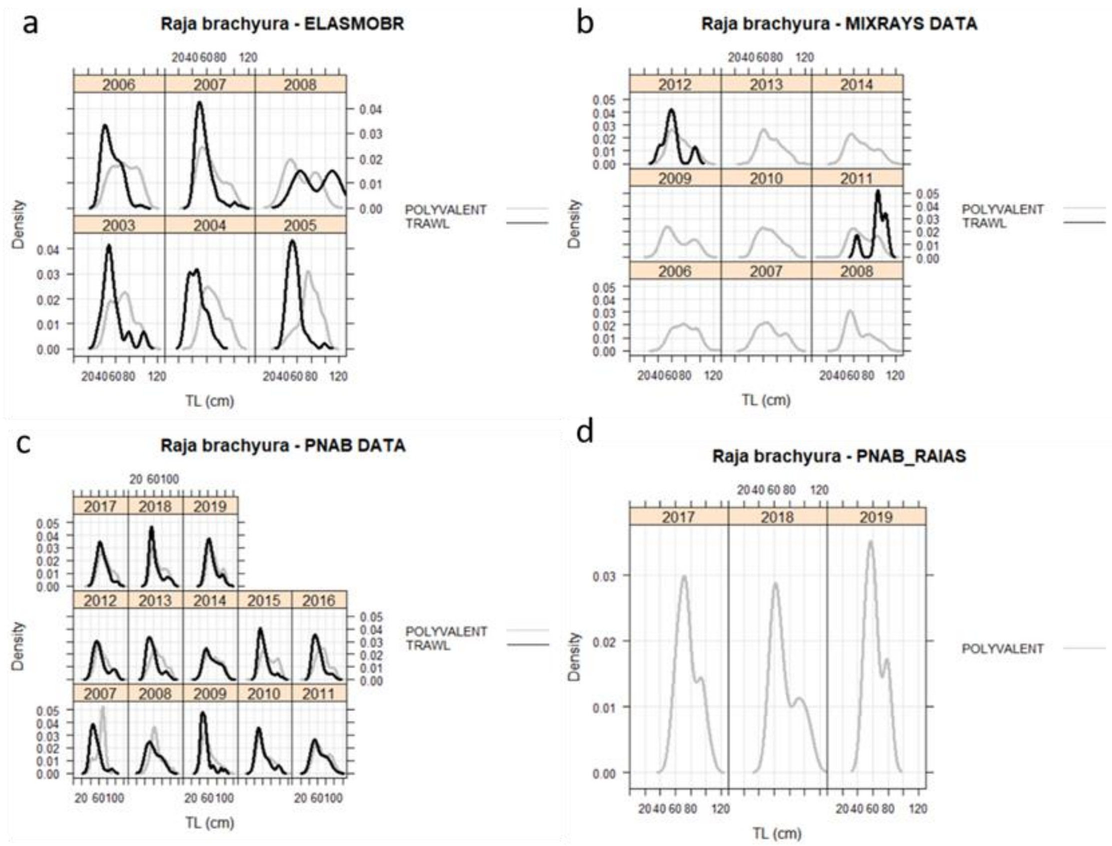


Figure 19.2h. Skates in the Bay of Biscay and Iberian Waters. Annual density plots of length of *R. brachyura* by segment for the different data sources: a) ELASMOBR; b) MIXRAYS; c) PNAB and; d) PNAB RAYS.

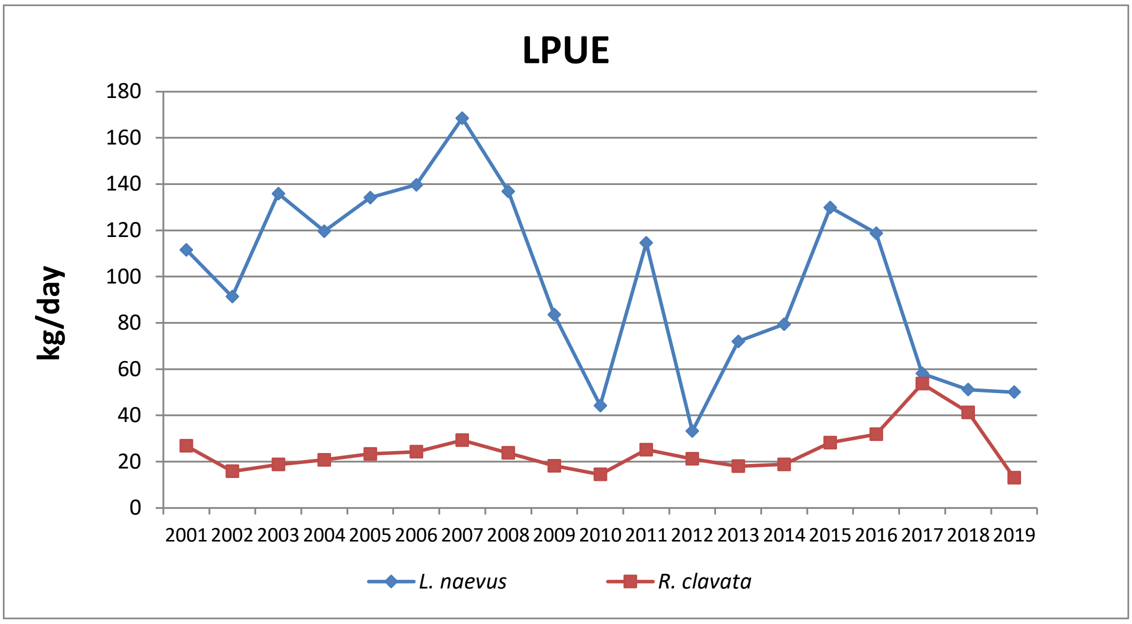


Figure 19.3. Skates in the Bay of Biscay and Iberian Waters. Nominal LPUE (kg day^{-1}) of *Leucoraja naevus* and *Raja clavata* caught in the OTB DEF >= 70 Basque fleet in Subarea 8 (2001–2019).

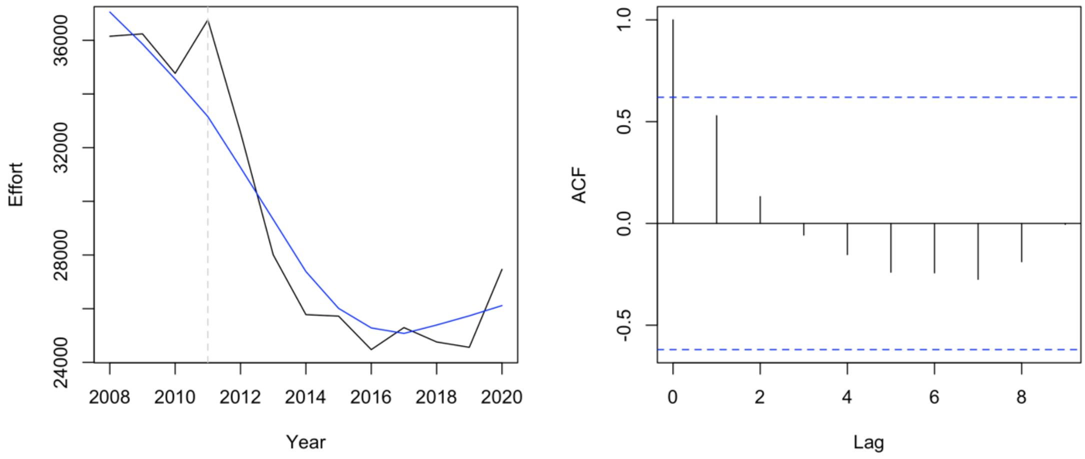


Figure 19.4a. Skates in the Bay of Biscay and Iberian Waters. Fishing effort time series (number of trips) with lowess smooth (in blue; left) and autocorrelation (ACF; right) for all skates and rays combined, caught by the polyvalent fleet in mainland Portugal (Division 9.a). The grey vertical line in the left plot indicates the threshold of the last 10 years of the time series, for which the Mann-Kendall trend test and the ACF were estimated.

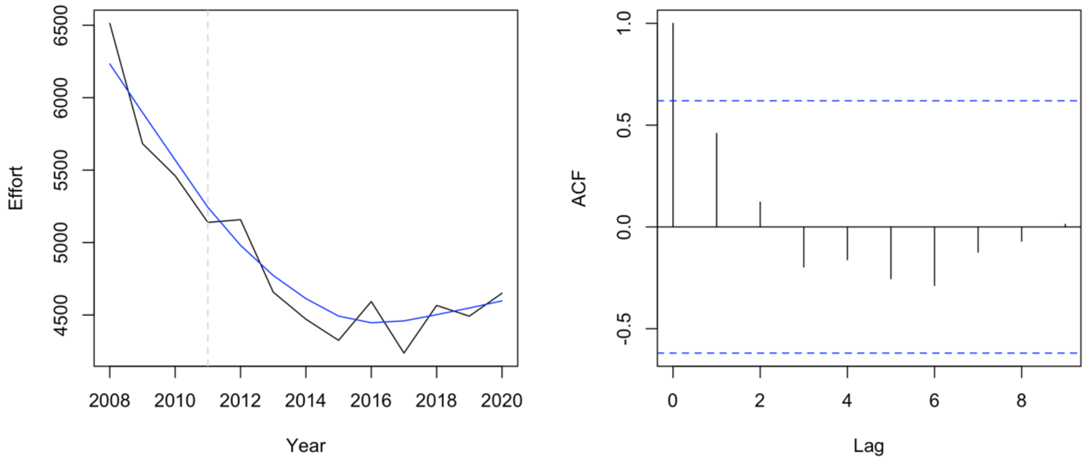


Figure 19.4b. Skates in the Bay of Biscay and Iberian Waters. Fishing effort time series (number of trips) with lowess smooth (in blue; left) and autocorrelation (ACF; right) for all skates and rays combined, caught by the trawl fleet in mainland Portugal (Division 9.a). The grey vertical line in the left plot indicates the threshold of the last 10 years of the time series, for which the Mann-Kendall trend test and the ACF were estimated.

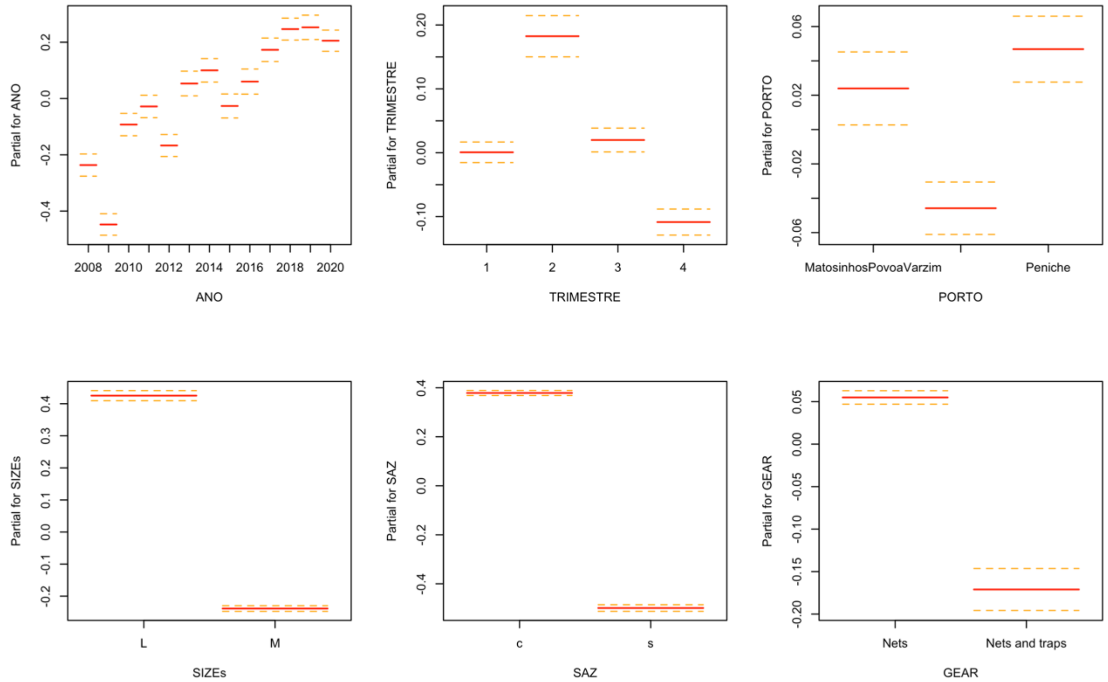


Figure 19.4c. Skates in the Bay of Biscay and Iberian Waters. Effect of each explanatory variable included in the standardization of the LPUE for *R. clavata* caught by the polyvalent segment in mainland Portugal (Division 9.a): year, quarter, landing port, vessel size ("SIZEs"), fishing seasonality ("SAZ") and fishing gear (trammel nets or gillnets).

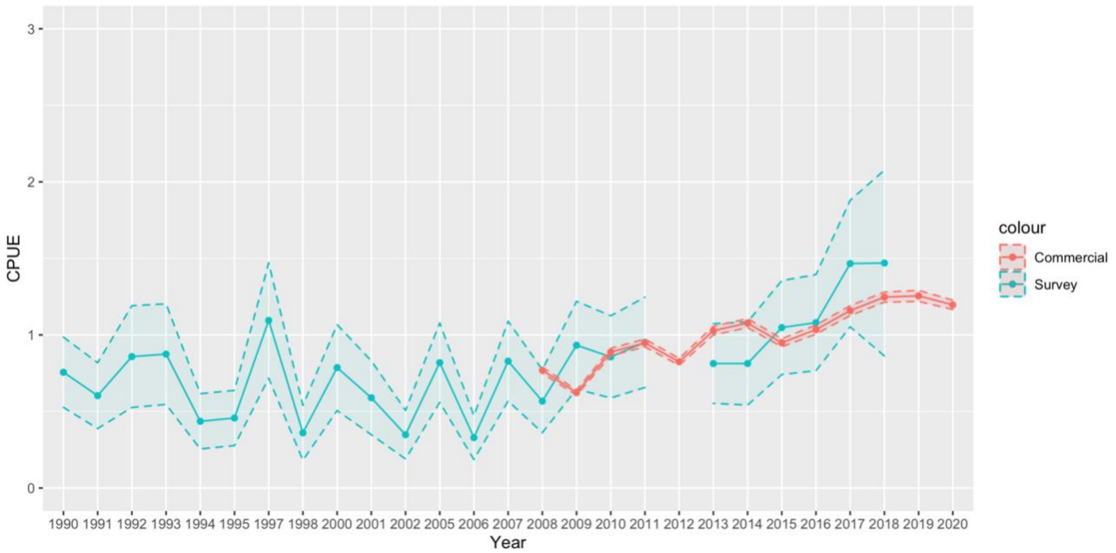


Figure 19.4d. Skates in the Bay of Biscay and Iberian Waters. Standardized LPUE from the polyvalent segment in mainland Portugal vs standardized PtGFS-WIBTS-Q4 Survey biomass Index for *R. clavata* (Division 9.a). Both series are normalized to the long-term mean and present the standard errors in shade.

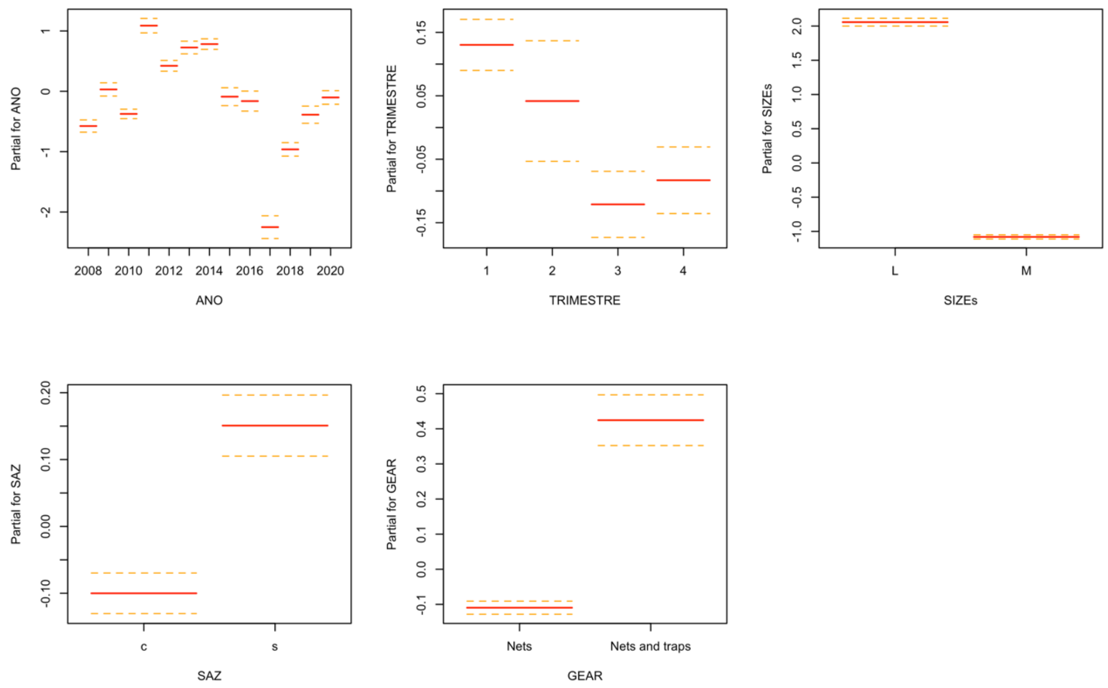


Figure 19.4e. Skates in the Bay of Biscay and Iberian Waters. Effect of each explanatory variable included in the standardization of the LPUE for *L. naevus* caught by the polyvalent segment in mainland Portugal (Division 9.a): year, quarter, landing port, vessel size ("SIZEs"), fishing seasonality ("SAZ") and fishing gear (trammel nets or gillnets).

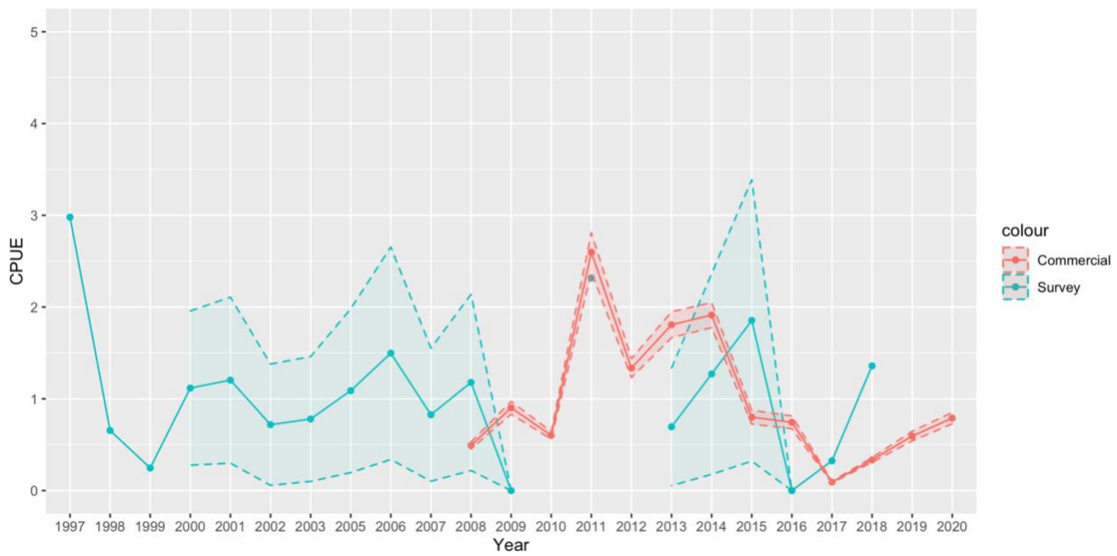


Figure 19.4f. Skates in the Bay of Biscay and Iberian Waters. Standardized LPUE from the polyvalent segment in mainland Portugal vs standardized NepS (FU 28–29) Survey biomass Index for *L. naevus* (Division 9.a). Both series are normalized to the long-term mean and present the standard errors in shade.

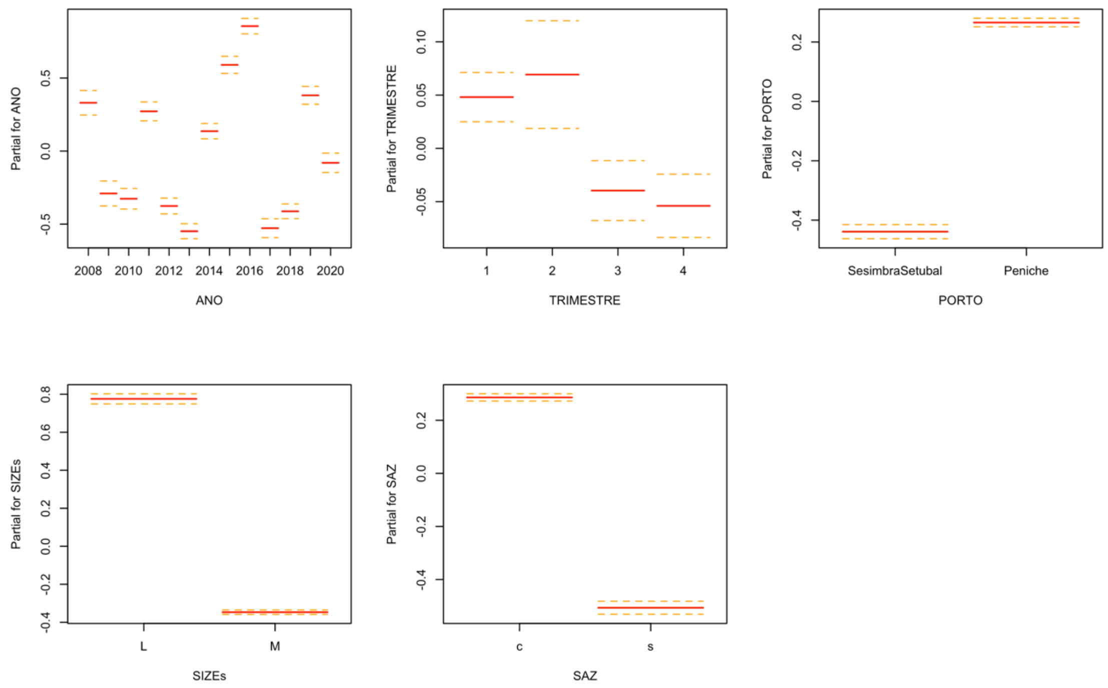


Figure 19.4g. Skates in the Bay of Biscay and Iberian Waters. Effect of each explanatory variable included in the standardization of the LPUE for *R. montagui* caught by the polyvalent segment in mainland Portugal (Division 9.a): year, quarter, landing port, vessel size ("SIZEs"), fishing seasonality ("SAZ") and fishing gear (trammel nets or gillnets).

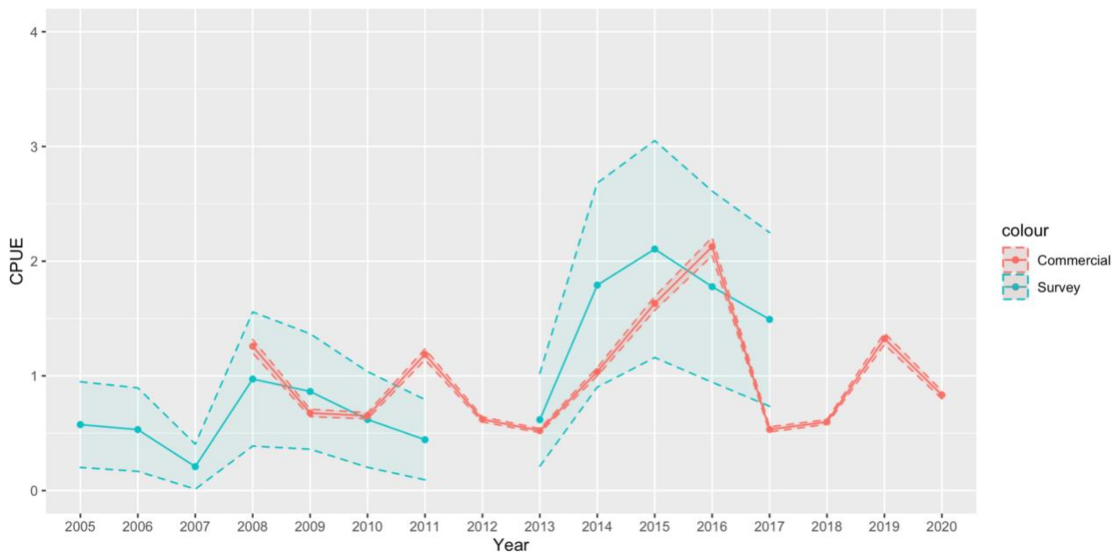


Figure 19.4h. Skates in the Bay of Biscay and Iberian Waters. Standardized LPUE from the polyvalent segment in mainland Portugal vs standardized PtGFS-WIBTS-Q4 Survey biomass Index for *R. montagui* (Division 9.a). Both series are normalized to the long-term mean and present the standard errors in shade.

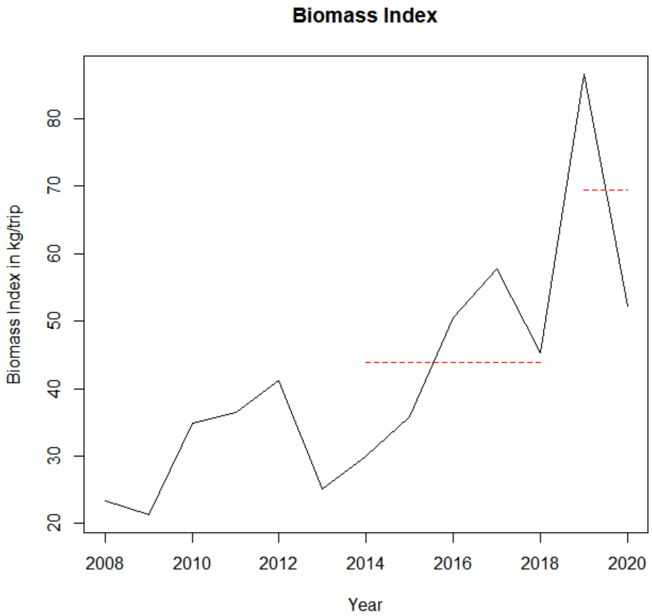


Figure 19.4i. Skates in the Bay of Biscay and Iberian Waters. Annual standardized CPUE estimates (kg trip^{-1}) of *R. brachyura* in the Division 9.a of the Portuguese Polyvalent fleet for the period 2008–2020.

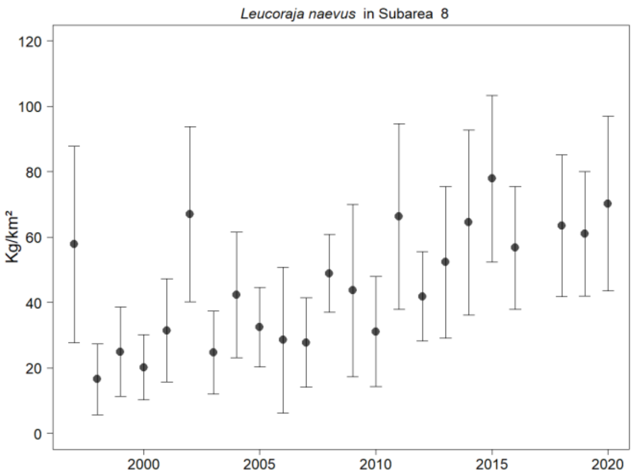


Figure 19.5a. Skates in the Bay of Biscay and Iberian Waters. Biomass indices 1987 index (kg km^{-2}) of *L. naevus* from the EVHOE survey 1997–2020 in divisions 8.abd.

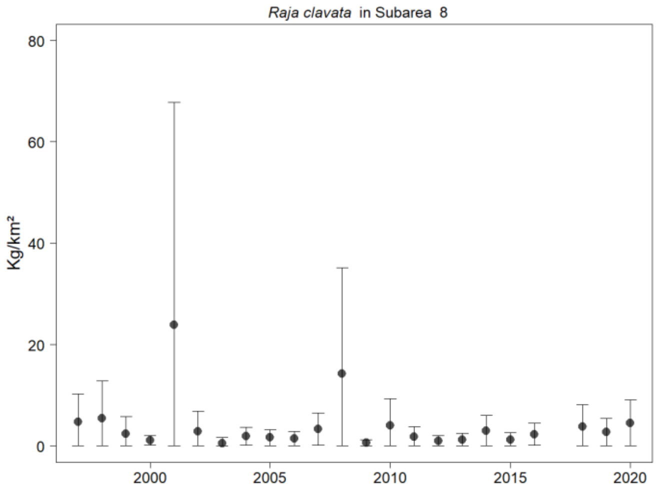


Figure 19.5b. Skates in the Bay of Biscay and Iberian Waters. Biomass indices index (kg km^{-2}) of *R. clavata* from the EVHOE survey, 1997–2020 in divisions 8.abd.

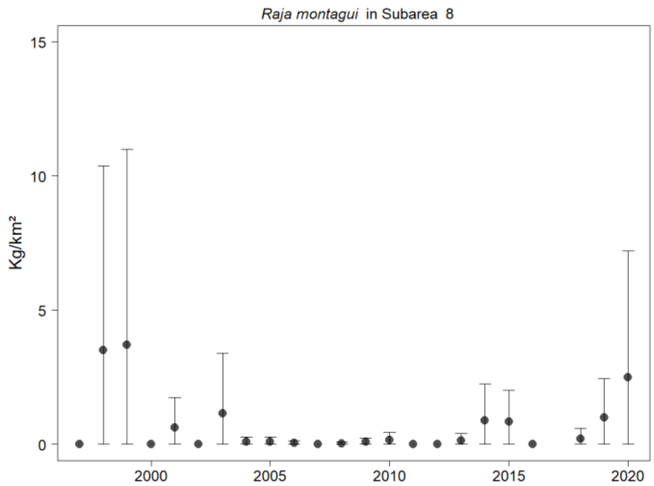


Figure 19.6c. Skates in the Bay of Biscay and Iberian Waters. Biomass indices index (kg km^{-2}) of *R. montagui* from the EVHOE survey, 1997–2020 in divisions 8.abd.

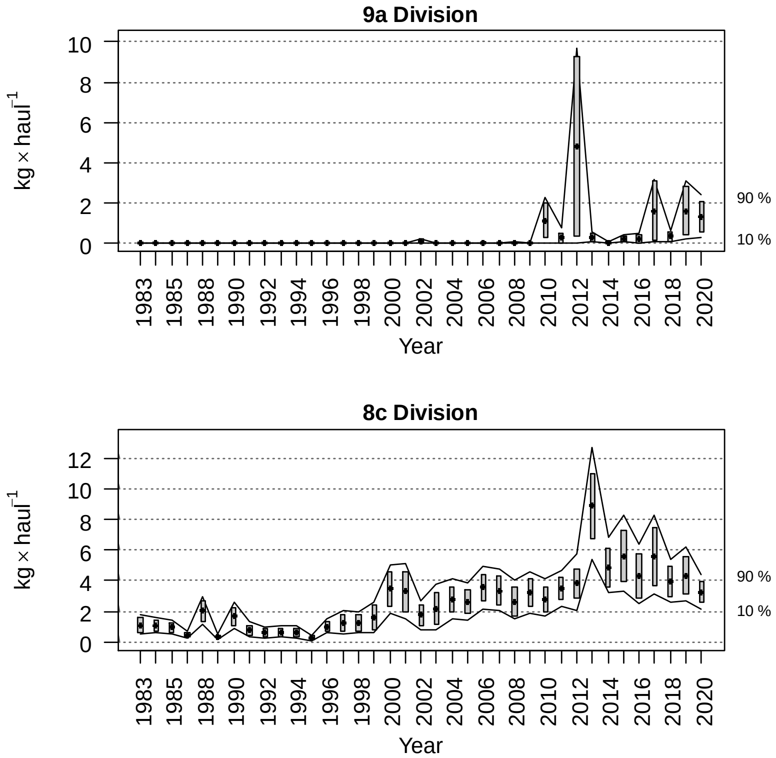


Figure 19.6a. Skates in the Bay of Biscay and Iberian waters. Time-series of *Raja clavata* biomass indices, in ICES divisions 9.a and 8.c, during the North Spanish bottom trawl survey (1983–2020). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α = 0.80, bootstrap iterations = 1000).

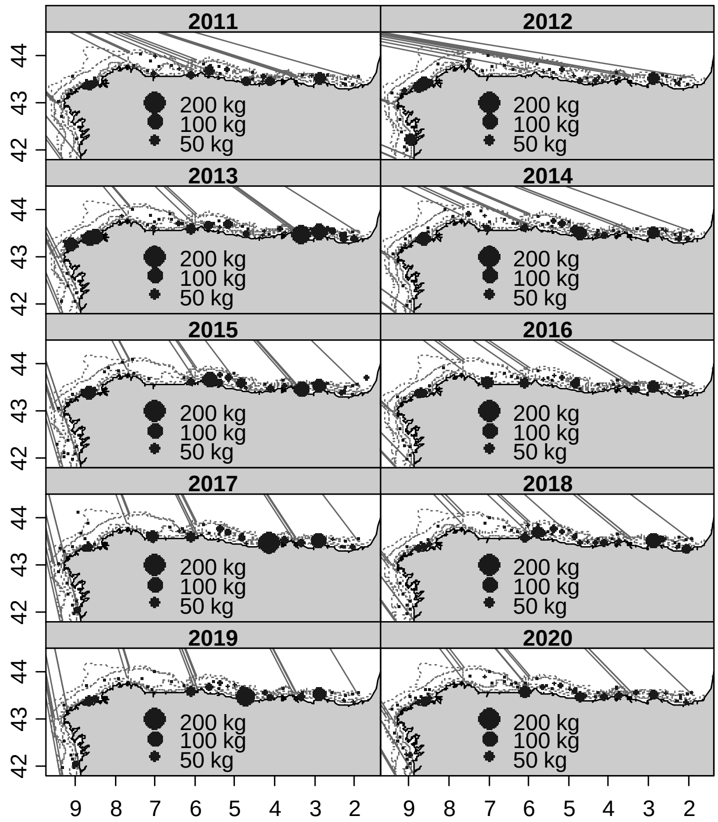


Figure 19.6b. Skates in the Bay of Biscay and Iberian waters. Geographical distribution of *R. clavata* catches (kg/30 min haul) in North Spanish continental shelf from bottom trawl surveys for the period (2011–2020).

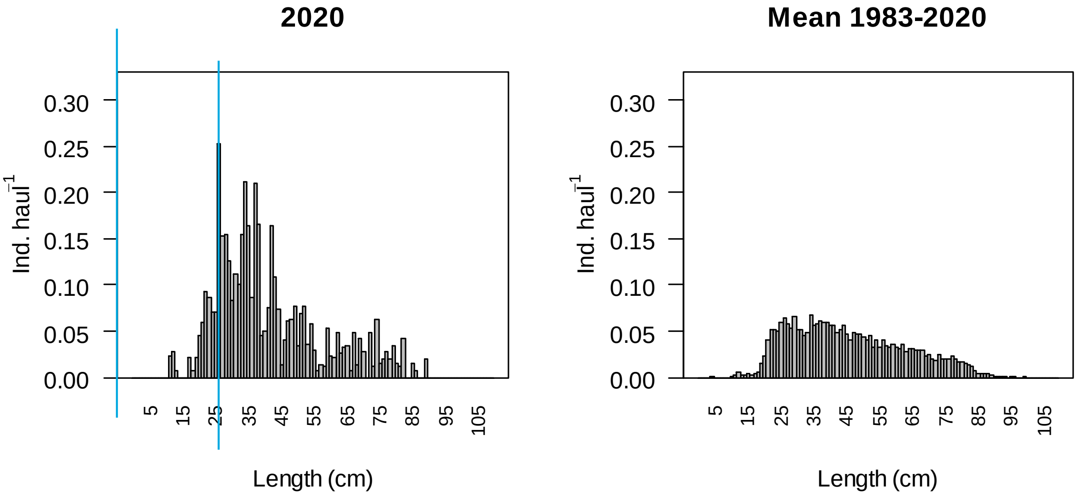
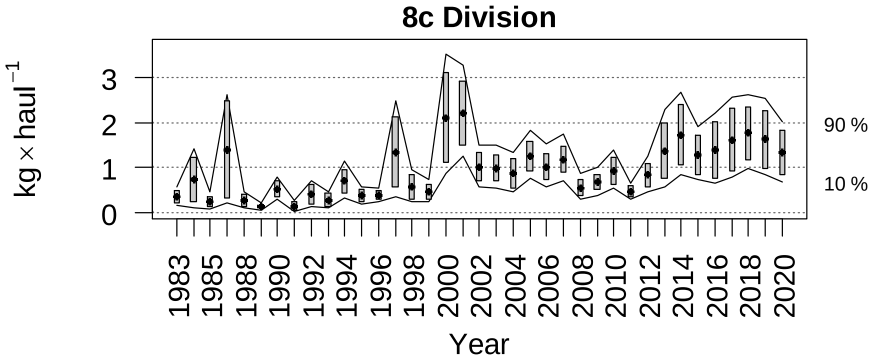


Figure 19.6c. Skates in the Bay of Biscay and Iberian waters. Stratified length distribution of *R. clavata* obtained from Spanish bottom trawl surveys time-series in the last survey (left) and in the period 1983–2020 (right) in Division 8.c of the North Spanish Shelf.



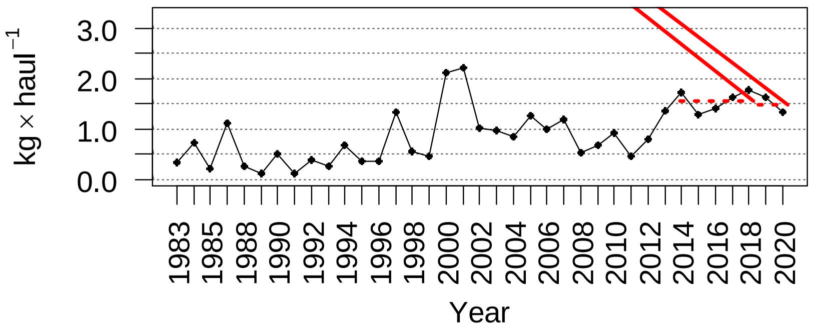


Figure 19.7a. Skates in the Bay of Biscay and Iberian Waters. Time-series of *Raja montagui* biomass index during North Spanish shelf bottom trawl survey (1983–2020) in Division 8.c covered by the survey. Top: boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000). Bottom: red lines show the average index in the two last years and in the five previous.

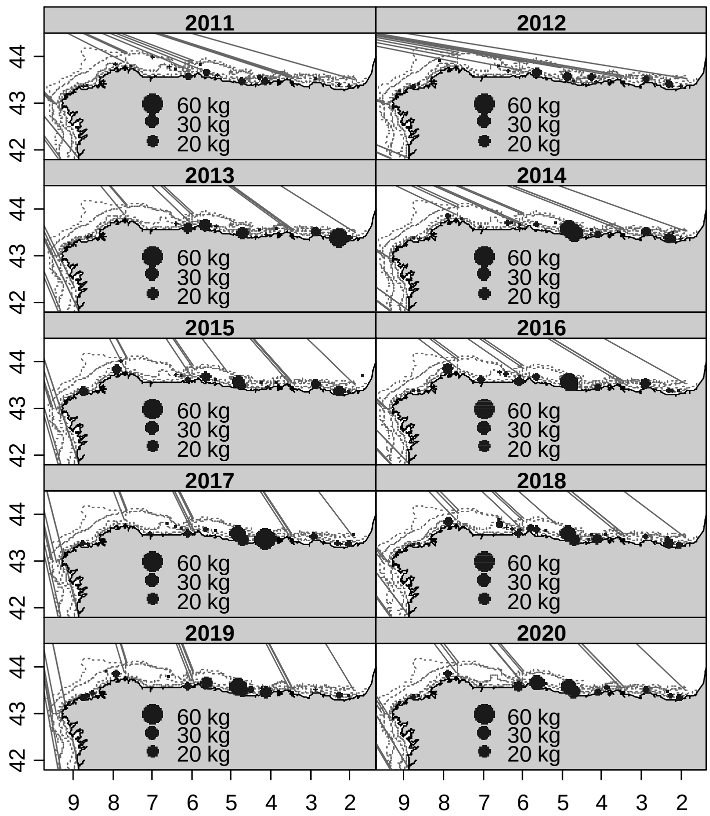


Figure 19.7b. Skates in the Bay of Biscay and Iberian Waters. Geographical distribution of *R. montagui* catches (kg/30 min haul) in North Spanish continental shelf bottom trawl surveys for the period (2011–2020).

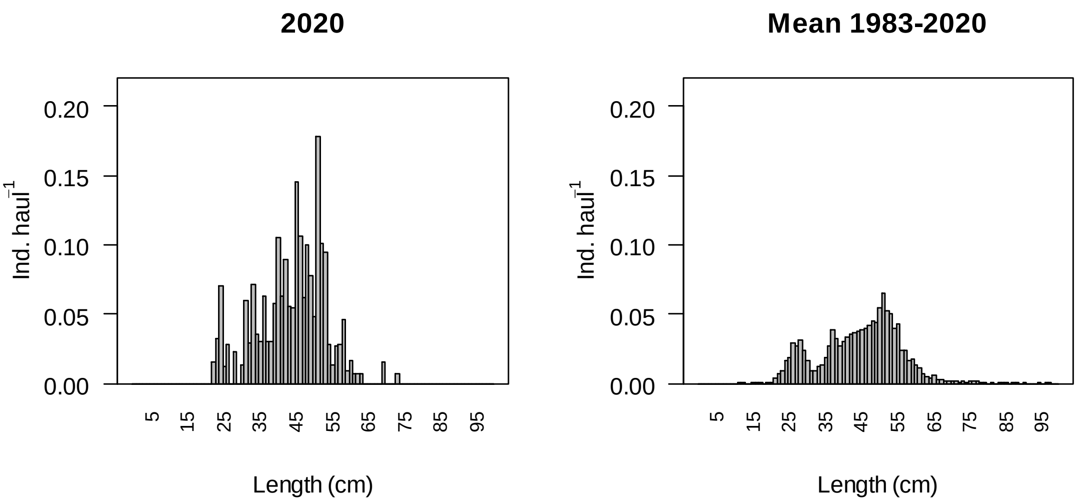


Figure 19.7c. Skates in the Bay of Biscay and Iberian waters. Mean stratified length distribution of *Raja montagui* in the last survey and in the period 1983–2020 (right) in Division 8.c of the North Spanish Shelf.

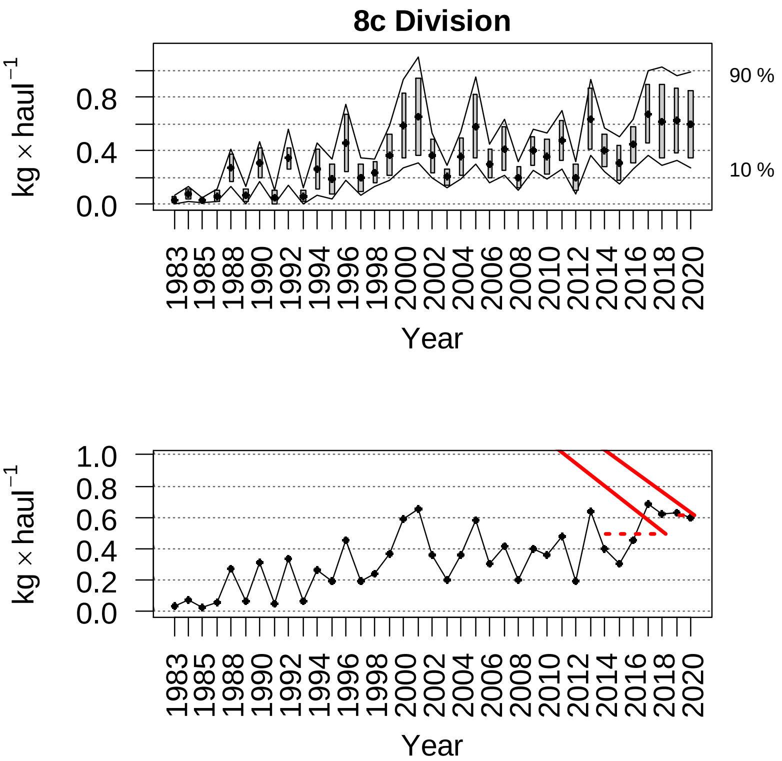


Figure 19.8a. Skates in the Bay of Biscay and Iberian Waters. Time-series of *Leucoraja naevus* biomass index during the North Spanish shelf bottom trawl survey (1983–2020) in ICES Division 8.c. Top: boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000). Bottom: red lines show the average index in the two last years and in the five previous.

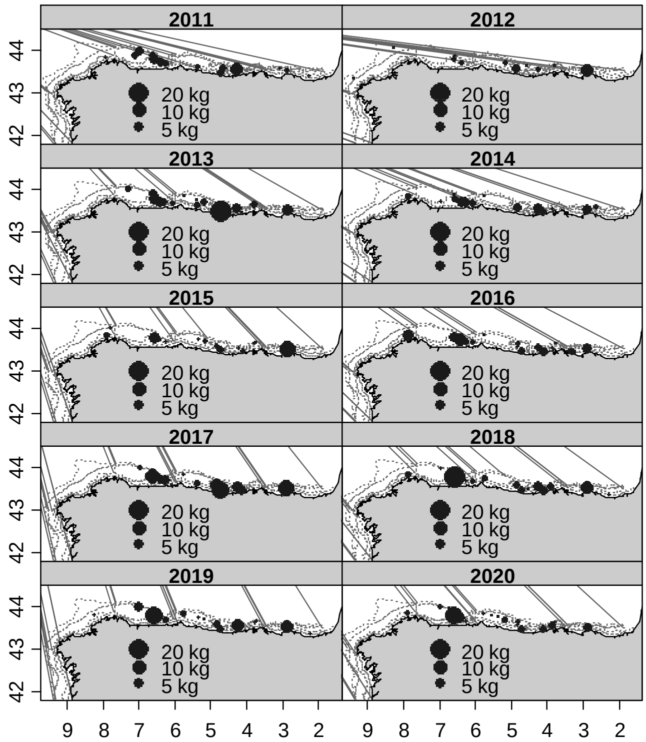


Figure 19.8b. Skates in the Bay of Biscay and Iberian Waters. Geographical distribution of *L. naevus* catches (kg/30 min haul) in North Spanish continental shelf bottom trawl surveys for the period (2011–2020).

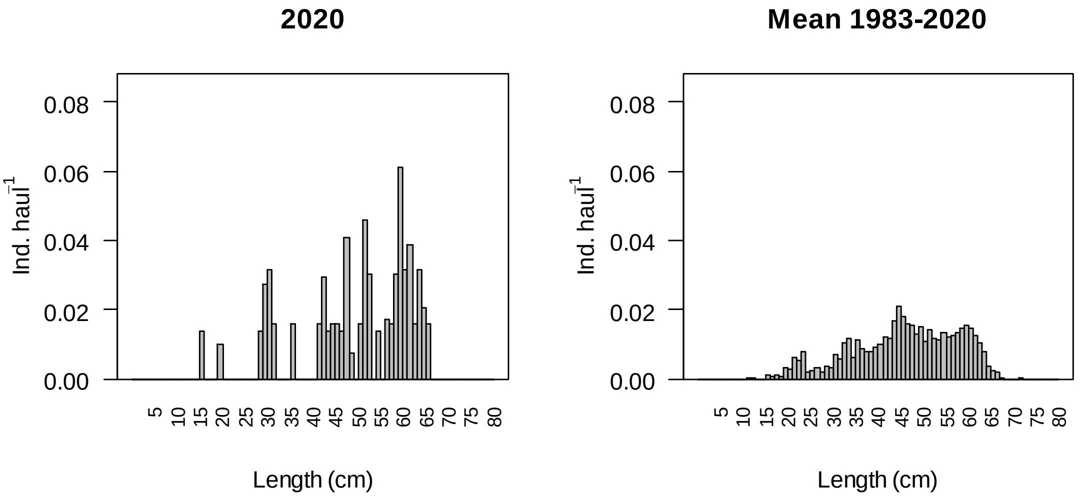


Figure 19.8c. Skates in the Bay of Biscay and Iberian waters. Mean stratified length distribution of *Leucoraja naevus* in the last survey (left) and in the period 1983–2020 (right) in Division 8.c of the North Spanish Shelf.

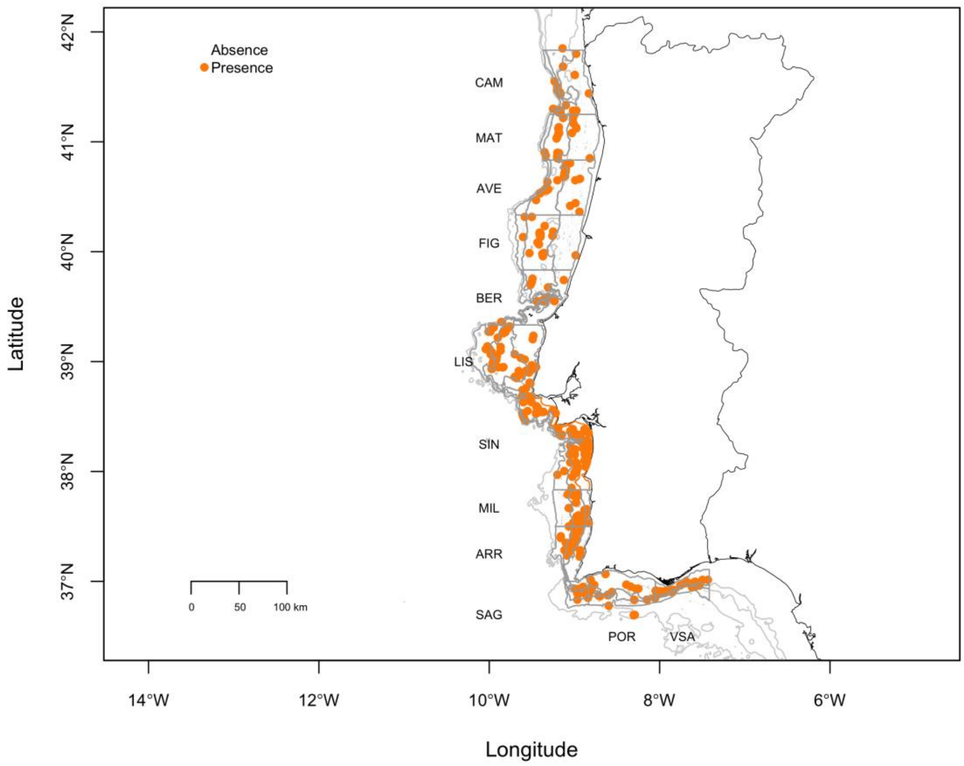


Figure 19.9a. Skates in the Bay of Biscay and Iberian Waters. *Raja clavata* distribution from 1981 to 2018 in the Portuguese Autumn Groundfish Survey (PtGFS-WIBTS-Q4).

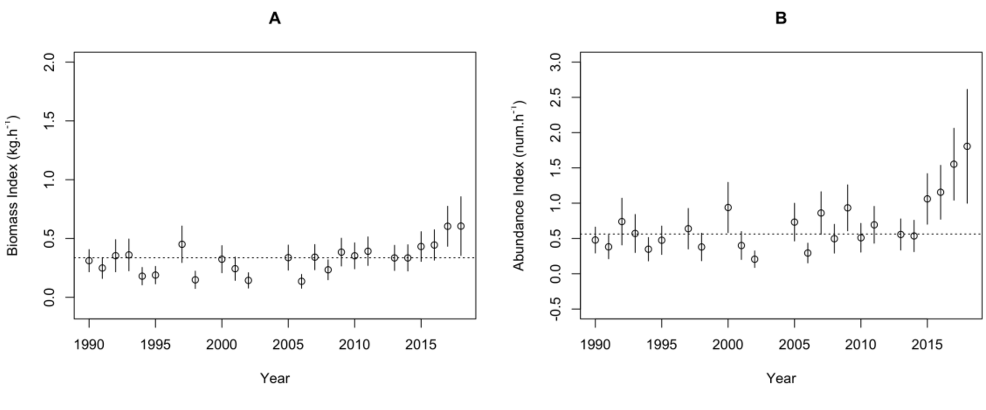


Figure 19.9b. Skates in the Bay of Biscay and Iberian Waters. *Raja clavata* A) biomass index (kg hour^{-1}) and B) abundance (ind.hour^{-1}) on PtGFS-WIBTS-Q4from 1990 to 2018. Dashed line represents the mean annual abundance for the considered period.

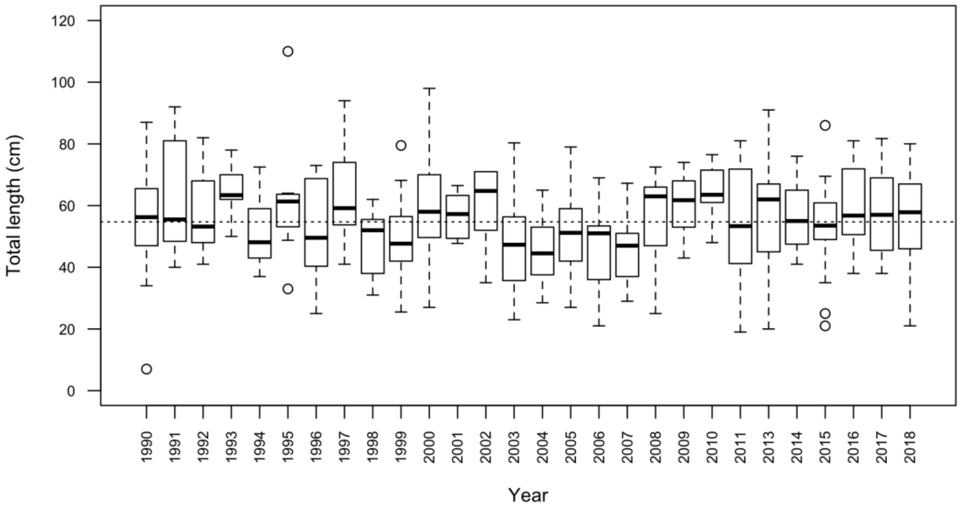


Figure 19.9c. Skates in the Bay of Biscay and Iberian Waters. Total length variation of *Raja clavata*, by year on PtGFS-WIBTS-Q4 (dashed line represents the mean annual length for 1990–2018).

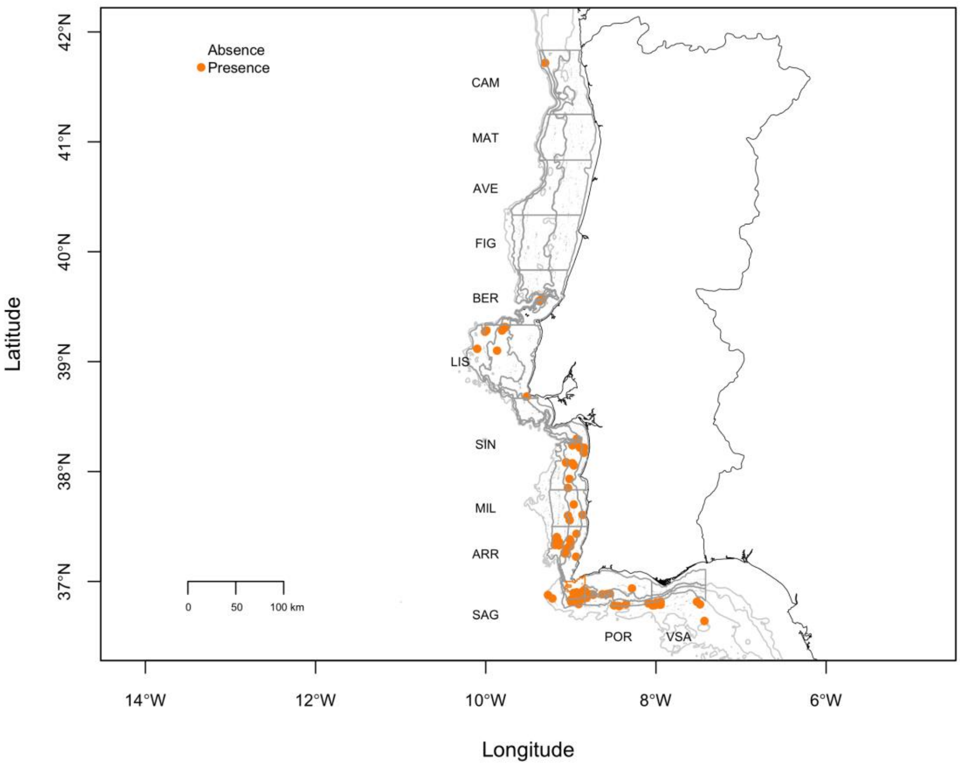


Figure 19.10a. Skates in the Bay of Biscay and Iberian Waters. *Leucoraja naevus* distribution from 1981 to 2018 in the Portuguese Autumn Groundfish Surveys (PtGFS-WIBTS-Q4), and Portuguese crustacean surveys/*Nephrops* TV surveys (PT-CTS (UWTV (FU 28-29).

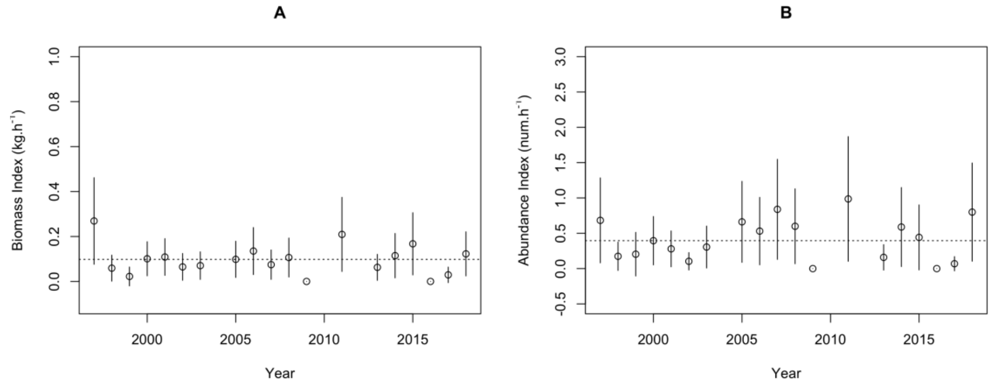


Figure 19.10b. Skates in the Bay of Biscay and Iberian Waters. *Leucoraja naevus* A) biomass index (kg hour^{-1}) and B) abundance (ind.hour^{-1}) on PT-CTS (UWTV (FU 28-29) from 1997 to 2018. Dashed line represents the mean annual abundance for the considered period.

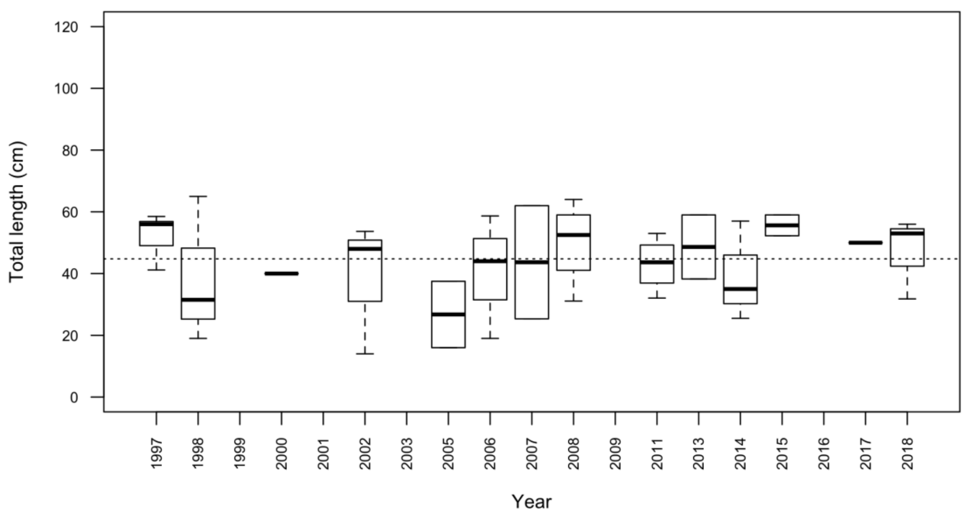


Figure 19.10c. Skates in the Bay of Biscay and Iberian Waters. Total length variation of *Leucoraja naevus*, by year on PT-CTS (UWTV (FU 28-29) (dashed line represents the mean annual length for 1997–2018).

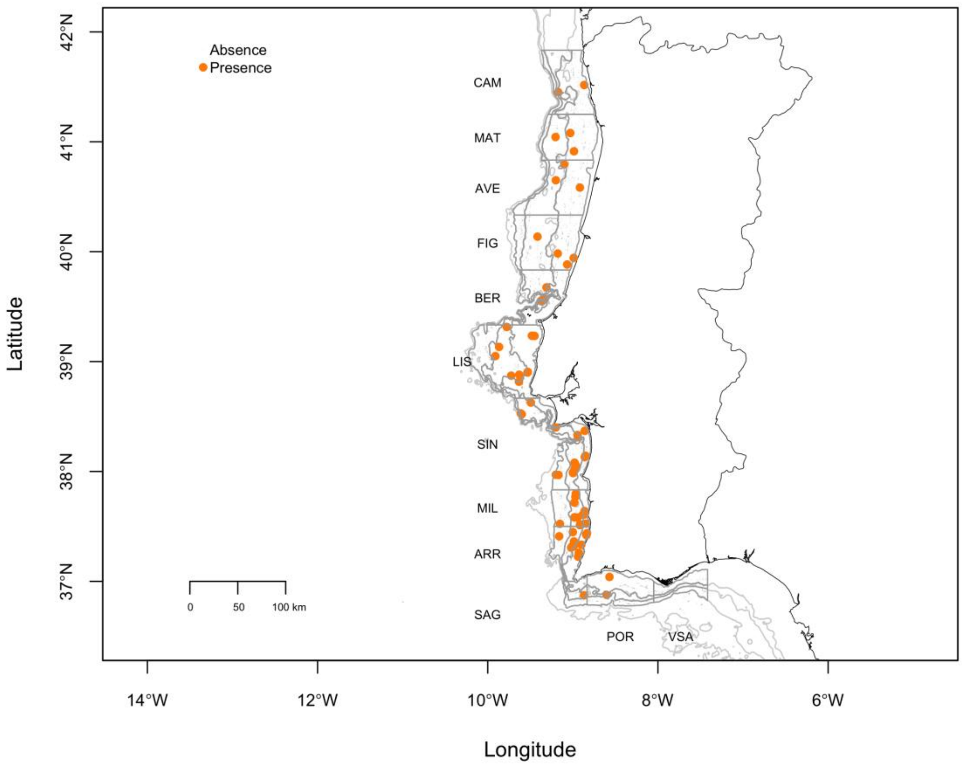


Figure 19.11a. Skates in the Bay of Biscay and Iberian Waters. *Raja montagui* distribution from 1981 to 2018 in the Portuguese Autumn Groundfish Surveys (PtGFS-WIBTS-Q4).

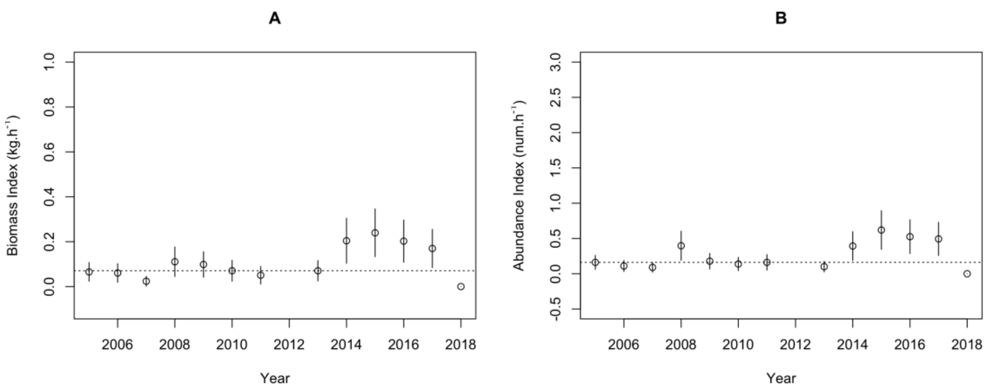


Figure 19.11b. Skates in the Bay of Biscay and Iberian Waters. *Raja montagui* biomass index (kg hour^{-1}) and abundance (ind. hour^{-1}) on PtGFS-WIBTS-Q4from 1990 to 2018. Dashed line represents the mean annual abundance for the considered period.

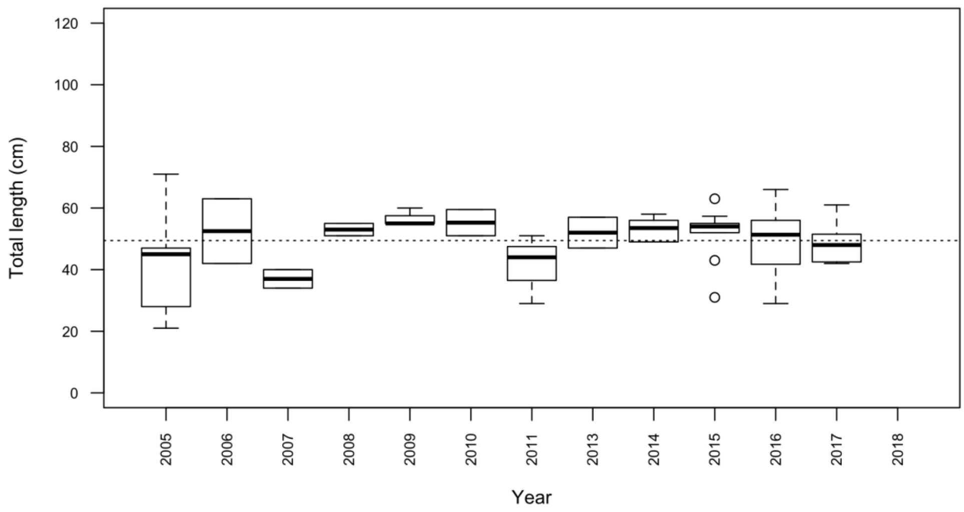
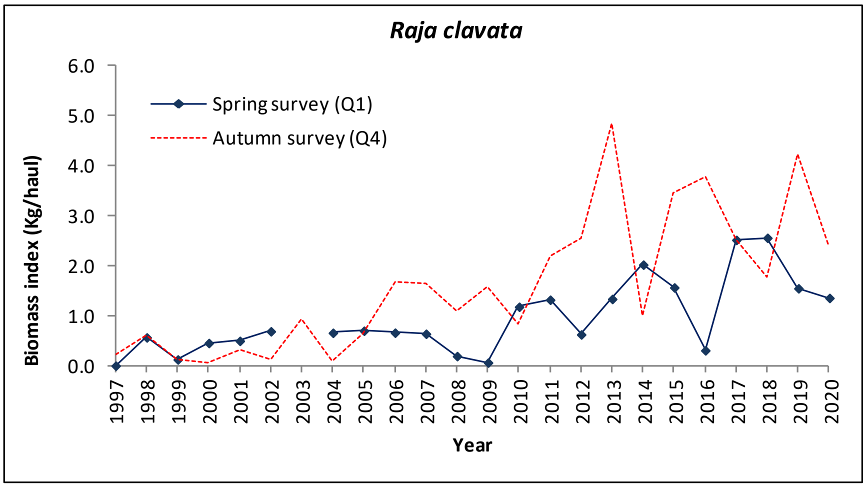


Figure 19.11c. Skates in the Bay of Biscay and Iberian Waters. Total length variation of *Raja montagui*, by year on PtGFS-WIBTS-Q4 (dashed line represents the mean annual length for 1990–2018).



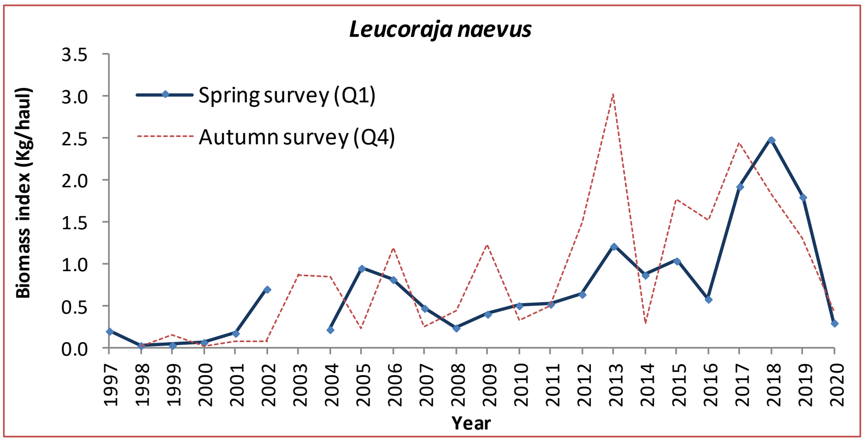


Figure 19.12a. Skates in the Bay of Biscay and Iberian Waters. Biomass index expressed as kg per haul of *R. clavata* (top) and *L. naevus* (below) from the Spanish bottom trawl surveys ARSA carried out in spring (Q1) and autumn (Q4) in the Gulf of Cadiz (ICES 9.a South) from 1997 to 2020.

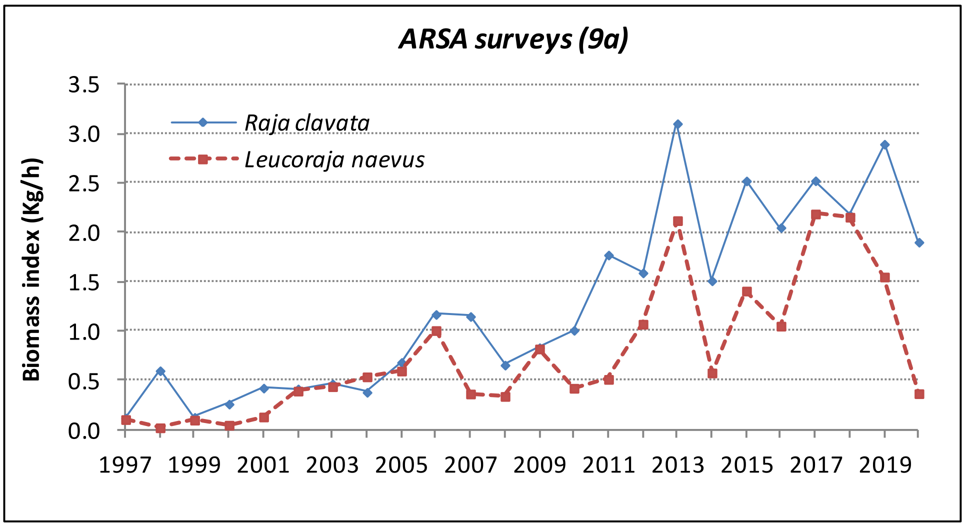


Figure 19.12b. Skates in the Bay of Biscay and Iberian Waters. Trend of the yield of *R. clavata* and *L. naevus* expressed as kg per haul from the Spanish bottom trawl survey ARSA carried out in spring and autumn in the Gulf of Cadiz (9.a South) from 1997 to 2020. The average of both surveys Q1 and Q4 has been represented.

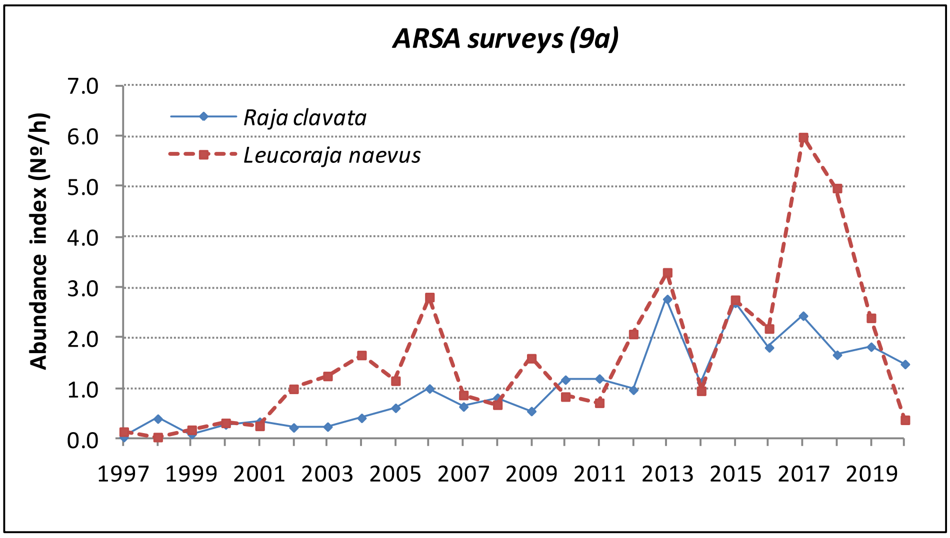


Figure 19.12c. Skates in the Bay of Biscay and Iberian Waters. Trend of the yield of *R. clavata* and *L. naevus* expressed as number per haul from the Spanish bottom trawl survey ARSA carried out in spring (Q1) and autumn (Q4) in the Gulf of Cadiz (9.a South) from 1997 to 2020. The average of both surveys Q1 and Q4 has been represented.

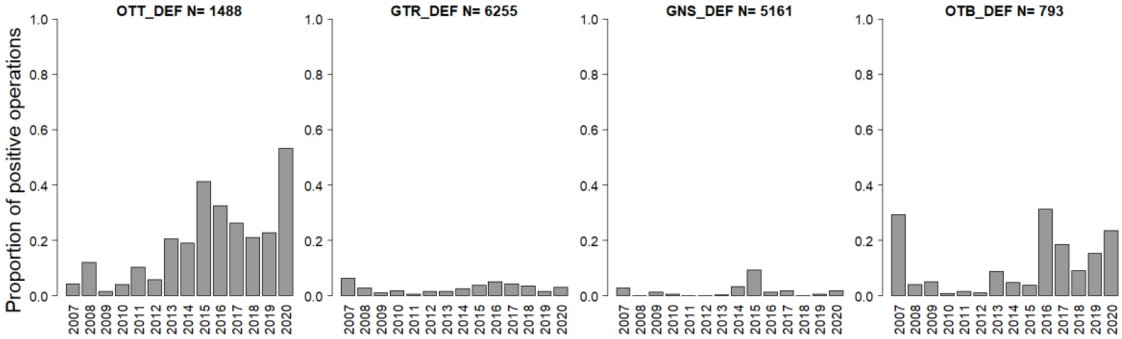


Figure 19.13a. Skates in the Bay of Biscay and Iberian Waters. *Raja clavata* in Subarea 8 (rjc.27.8). Occurrence indicators from the French on-board observer trips carried out in application of EU data collection programmes in 8abd. N: total number of fishing operations observed for the métier from 2007 to 2020.

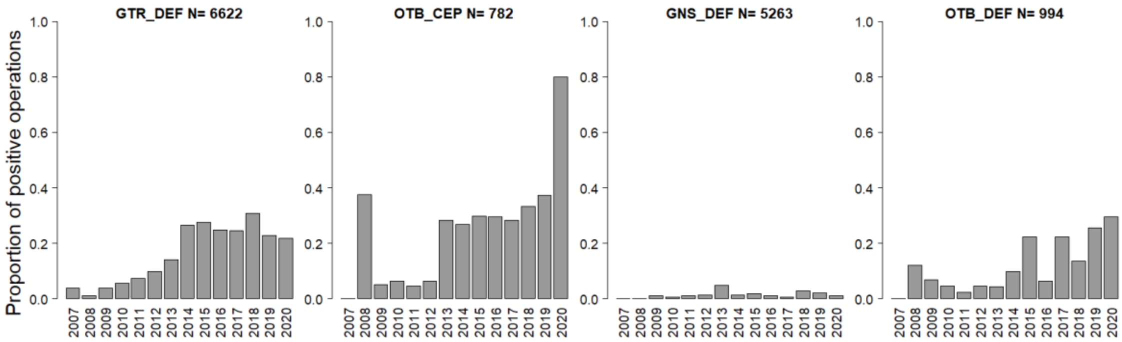


Figure 19.13b. Skates in the Bay of Biscay and Iberian Waters. *Raja undulata* in divisions 8.ab (rju.27.8ab). Occurrence indicators from the French on-board observer trips carried out in application of EU data collection programmes in 8.ab. N: total number of fishing operations observed by métier from 2007 to 2020.

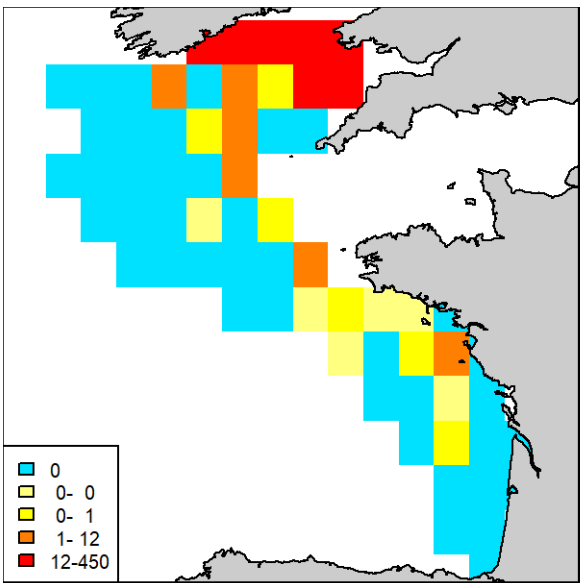


Figure 19.14. Skates in the Bay of Biscay and Iberian Waters. Spatial distribution of *Raja montagui* in ICES divisions 7.f-k and 8.a-c, based on catch in the EVHOE survey from 1997 to 2019.

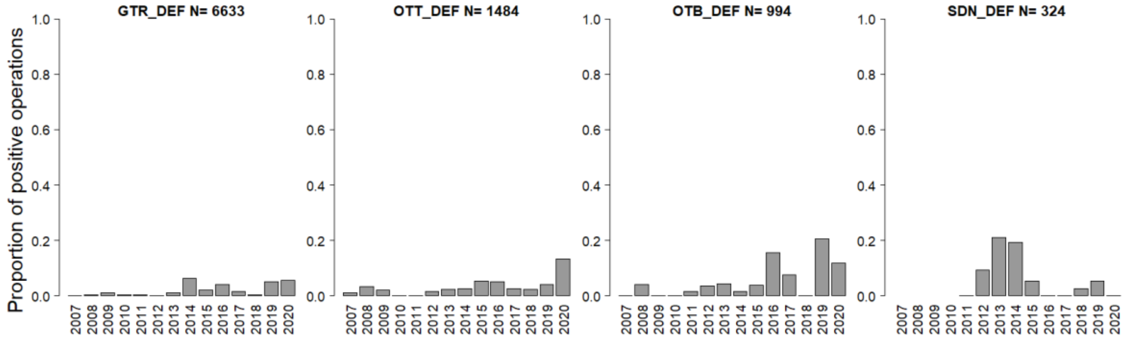


Figure 19.15. Skates in the Bay of Biscay and Iberian Waters. *Raja montagui* in Subarea 8 (rjm.27.8). Occurrence indicators from the French on-board observer trips carried out in application of EU data collection programmes in divisions 8.abd. N: total number of fishing operations observed for the métier from 2007 to 2020.

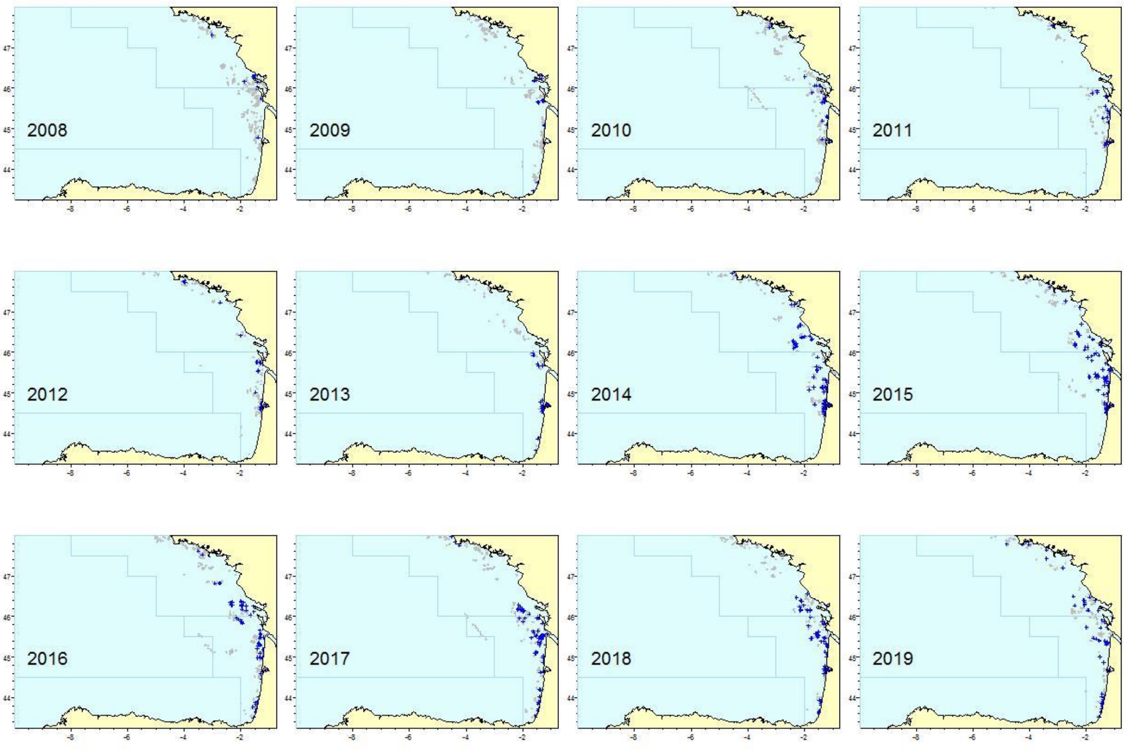


Figure 19.16. Skates in the Bay of Biscay and Iberian Waters. Spatial distribution of catches of *Raja undulata* in divisions 8.ab (rju.27.8ab) in trammel net (DCF level 5 métier GTR_DEF) from French on-board observer trips carried out in application of EU data collection programmes in 8.ab. from 2008 to 2019, grey: locations of all observed fishing operations of the métier, blue: fishing operations with catch of *Raja undulata*. Data used to estimate the frequency of occurrence (Figure 19.13b, leftmost panel).

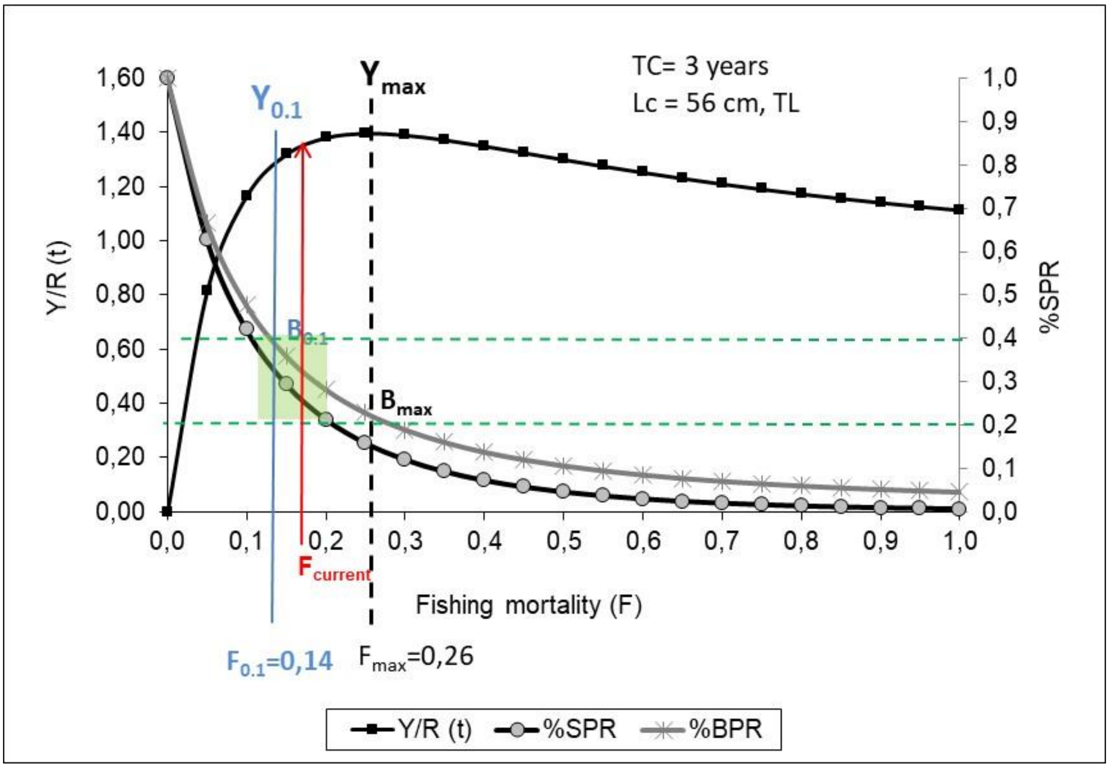


Figure 19.17. Skates in the Bay of Biscay and Iberian Waters. *Raja brachyura* yield per recruit (Y/R and potential spawning ratio (%SPR) curves for different levels of fishing mortality and an age of first capture = 3 years (TC). Red line shows $F_{current}$. *Raja brachyura*.

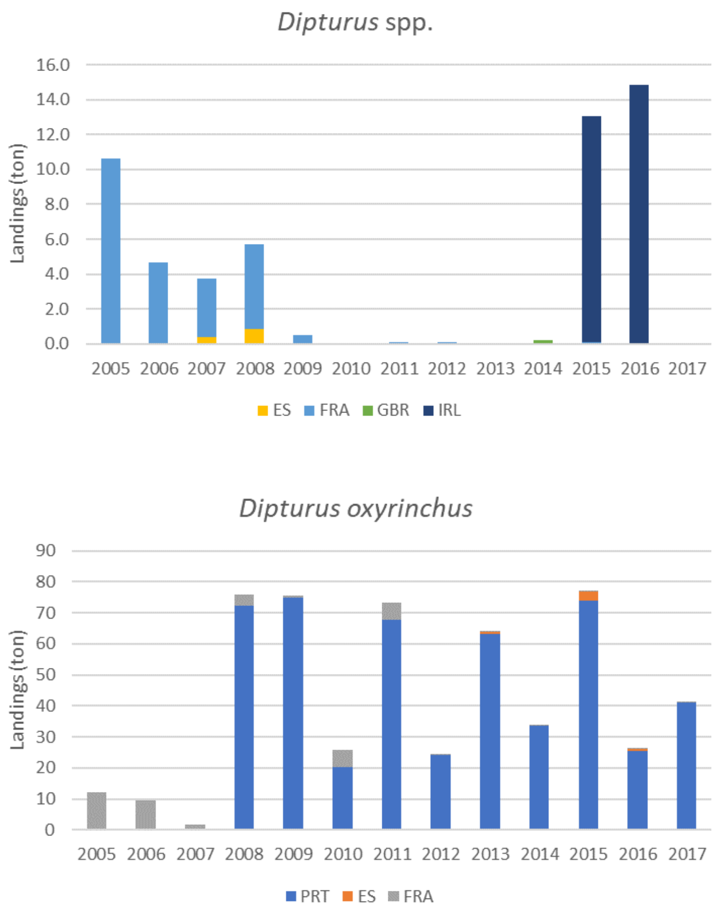


Figure 19.18. Landings (t) of *Dipturus* spp. and *Dipturus oxyrinchus by country* for Subarea 8 and Division 9.a (2004–2017).

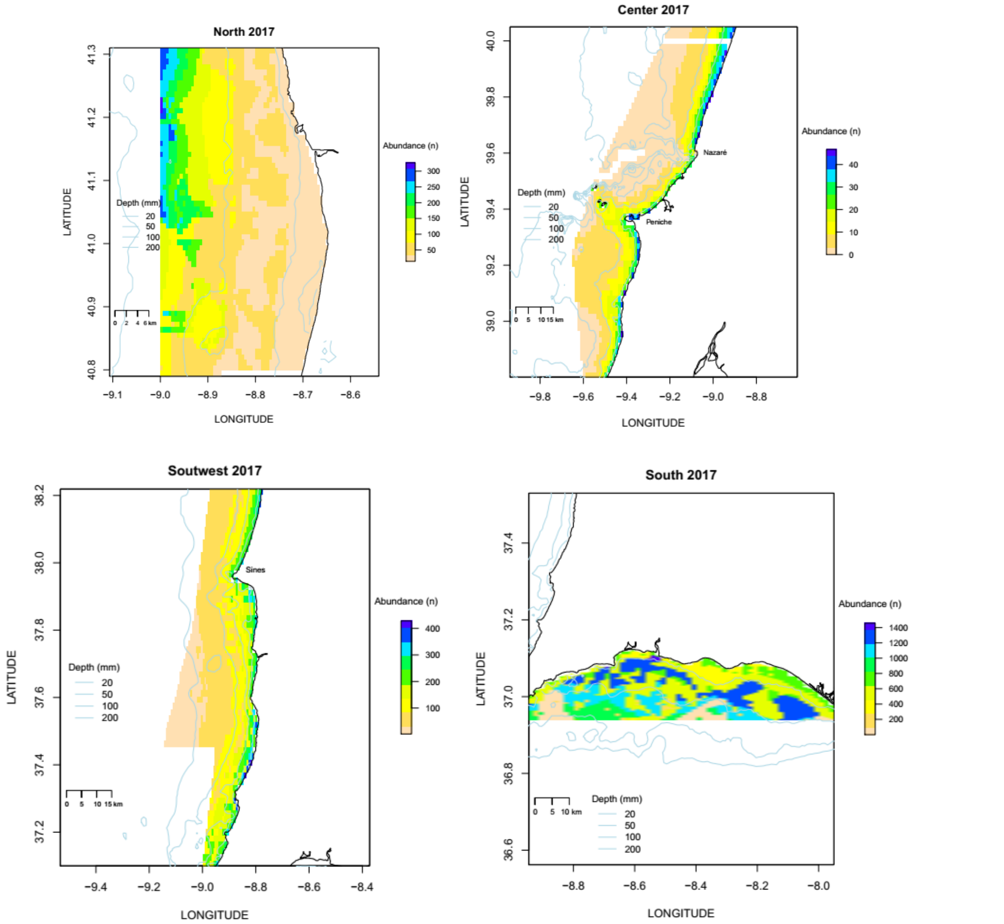


Figure 19.19: Skates in the Bay of Biscay and Iberian Waters. *Raja undulata* potential abundance by region for 2017.

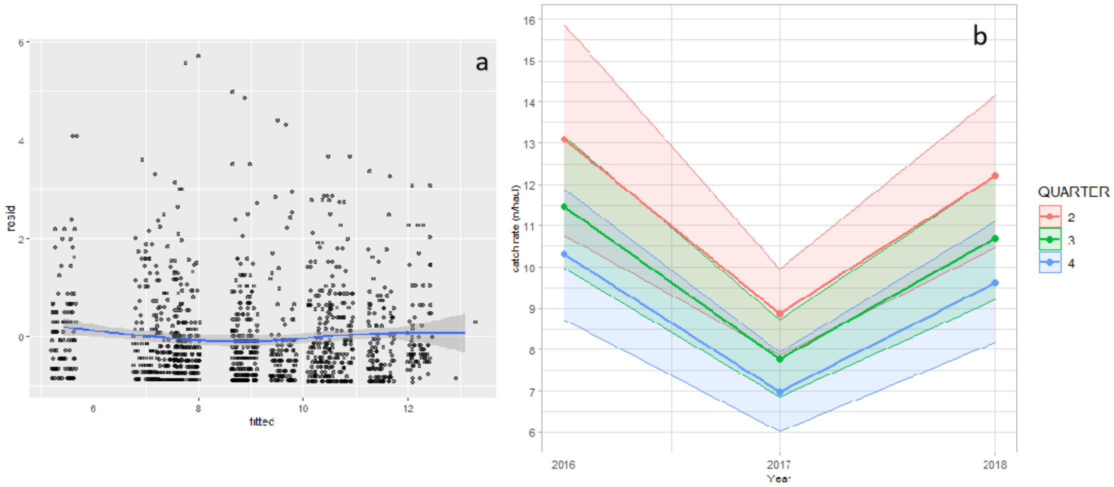


Figure 19.20: Skates in the Bay of Biscay and Iberian Waters. *Raja undulata* a) zero-truncated poisson regression model plot of the residuals versus fitted values and b) Standardized CPUE (kg trip⁻¹) for the period 2016–2018 by year and quarter.

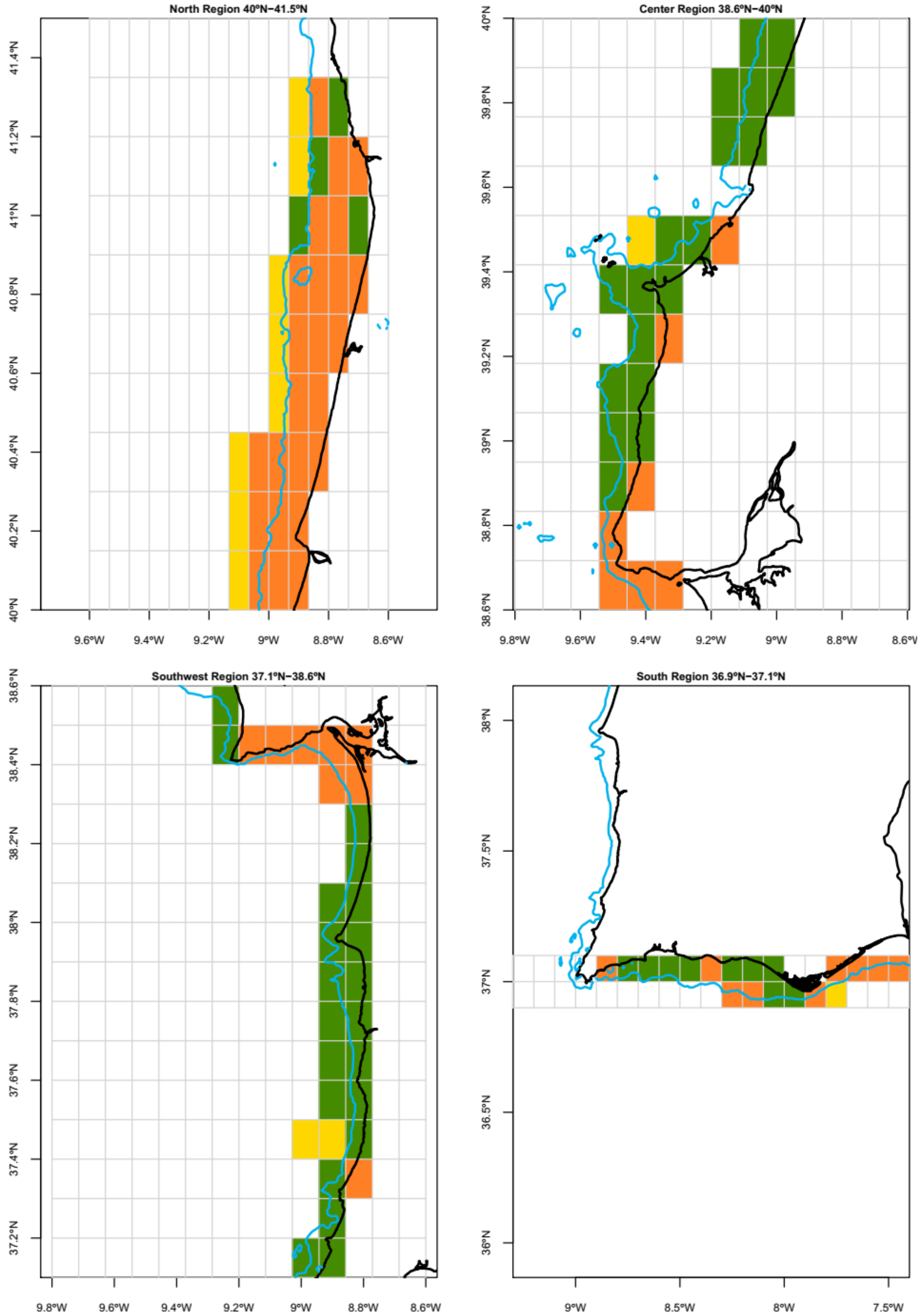


Figure 19.21. Skates in the Bay of Biscay and Iberian Waters. Sampling requirements for full spatial coverage of *Raja undulata* spatial distribution. Green - Spatial cells already sampled in 2016 and/or 2017 that need to continue to be monitored; Orange: - Spatial cells not sampled yet that need to be sampled with priority and; Yellow: Spatial cells not sampled yet that need to be sampled with lower priority.

20 Skates and Rays in the Azores and Mid-Atlantic Ridge

20.1 Ecoregion and stock boundaries

The Mid-Atlantic Ridge (MAR; ICES subareas 10.a, b, 12.a1, c, and 14. b1) is an extensive and diverse area, which includes several types of ecosystem, including abyssal plains, seamounts, active underwater volcanoes, chemosynthetic ecosystems and islands.

The main species of elasmobranch observed in this ecoregion are deep-water species (e.g. *Centrophorus* spp., *Centroscymnus* spp., *Deania* spp., *Etmopterus* spp., *Hexanchus griseus*, *Galeus murinus*, *Somniosus microcephalus*, *Pseudotriakis microdon*, *Scymnodon obscurus*, *Centroscyllium fabricii*; see sections 3 and 5 for more information). These species are mostly distributed deeper than 600 m. As a consequence of their low commercial value and EU restrictive management measures, many of these species are discarded (ICES, 2005; WD Pinho and Canha, 2011). The blue shark *Prionace glauca,* thornback ray *Raja clavata* and tope *Galeorhinus galeus* are the most important commercial elasmobranchs species in the Azores area (see sections 4 and 10 for blue shark and tope respectively).

The present section focuses on the skates taken in Azorean waters. Of these, the most abundant in Subarea 10 is thornback ray *Raja clavata*. Other species also observed include the 'common skate complex' (species to be confirmed), *Dipturus oxyrinchus*, *Leucoraja fullonica*, *Rajella bathyphila*, *Raja brachyura* and *Rostroraja alba* (WD Pinho, 2005, 2014b). Other species of batoids, such as Bigelow's ray *Rajella bigelowi* are also observed in this ecoregion (Santos *et al*., 2020a). All these species are generally discarded if caught in the Azorean commercial fisheries (WD Pinho and Canha, 2011). Some of the scarcer skates observed on MAR include *Bathyraja pallida* and *Bathyraja richardsoni* (ICES, 2005).

Stock boundaries are not known for most of the skate species in this area, neither are the potential movements of species that also occur on the continental shelf of mainland Europe. Genetic studies of *R. clavata* have indicated significant differences between Azorean and the eastern Atlantic sea board populations (Chevolot *et al.*, 2006; Ball *et al*., 2016), indicating that mixing is limited. Further investigations are necessary to determine potential migrations or interactions of skate populations within this ecoregion and neighbouring areas.

20.2 The fishery

20.2.1 History the fishery

Two broad types of fisheries occur in the Azores and MAR areas. Oceanic fisheries (large mid-water and bottom trawlers and longliners) operate in the central region and northern parts of the MAR. Longline and handline fisheries operate inside the Azorean EEZ, where trawling is prohibited. The latter fishery also targets stocks that may extend south of the ICES area, which southern limit is 36°N.

The fisheries from these areas were described in earlier WGEF reports (ICES, 2005). Landings from the Azorean fleets have been reported to ICES. Landings from the MAR are small and variable, or even absent, and few vessels find the MAR fisheries profitable at present.

Skates are caught in the Azores EEZ by a multispecies demersal fishery, using handlines and bottom longlines, and by the black scabbardfish fishery using bottom longlines (Santos *et al*., 2020a). The most commercially important skate caught and landed from these fisheries is *R. clavata* (Santos *et al*., 2020a).

20.2.2 The fishery in 2020

There are no target fisheries for skates in the Azores. An expansion of the Azorean bottom longline fishery to the more offshore seamounts has been observed in the last decade as a result of intensive fishing of important commercial demersal and deep-water stocks and also as a result of the introduction of spatial management measures (Santos *et al*., 2019).

Skate landings, particularly of *R. clavata,* increased in the Azores since 2009 until 2014. The highest ladings were reported in 2014 and 2015 and the long-term average is 179 t. Landings decreased in the last five years (tables 20.1–20.2; Figure 20.1). Prices in 2017 and 2018 were similar to previous years so that the lowest landing values from the full time series was recorded in 2019. The price of the thornback ray on local market does not seem to vary with quantity landed, suggesting that the market is limited, with little domestic consumption and limited demand for export. Although the fishery for this resource has these characteristics, the species is considered one of the twenty-two priority stocks in Azores (Santos *et al*., 2020b).

There are no fisheries targeting skates on the MAR (ICES subareas 10, 12 and 14) with sporadic landings in recent years (Table 20.1 and 20.2).

20.2.3 ICES advice applicable

For the Rajidae stock in subareas 10 and 12, ICES provides biennial advice. *ICES advises that when the precautionary approach is applied, landings should be no more than 75 tonnes in each of the years 2020 and 2021. ICES cannot quantify the corresponding catches.*

20.2.4 Management applicable

There is no EU TAC for skates and rays in the Azores and Mid-Atlantic Ridge. The only EU management measure susceptible to impact fisheries is the list of prohibited species. Amongst prohibited rays and skates only *Dipturus intermedius* may occur, but is not confirmed, in the stock area, so that the EU management might be considered as having no effect on fisheries.

20.2.4.1 Mid-Atlantic Ridge

NEAFC has adopted management measures for the MAR areas under its regulatory area (https://www.neafc.org/managing_fisheries/measures/current). These include effort limitations, area and gear restrictions.

20.2.4.2 Azores EEZ

In 1998, the Azorean government implemented local management actions in order to reduce effort on shallow areas around the islands, including a licence threshold based on the requirement of the minimum value of sales and the creation of a box of three miles around the islands, with fishing restrictions by gear (only handlines are permitted) and vessel type. During 2009, additional measures were implemented, including area restrictions (temporary closure of the Condor Bank) and gear restrictions by vessel type (licence and gear configuration) (Santos *et al*., 2020a). These technical measures have been updated thereafter (http://www.azores.gov.pt/gra/srmct-pescas/menus/principal/Legislação/).

In 2014, Portugal introduced a new regulation banning the use of bottom trawling and bottom gillnetting on the high seas in the area covered by Portugal's extended continental shelf under the UN Law of the Sea (Portaria n. º 114/2014, 28th May). The new regulation expands the EU regulation adopted in 2005 to ban bottom trawling in the Azores and Madeiran waters and has the key objective of protecting deep-sea ecosystems (such as cold-water corals and seamounts) from the impact of bottom trawling and gillnetting.

Under the EU Common Fisheries Policy, a box of 100 miles was created around the Azorean EEZ where only the Azorean fleets are allowed to line fish for deep-sea species (Regulation EC 1954/2003).

20.3 Catch data

20.3.1 Landings

The landings reported by each country and subarea are given in Tables 20.1–20.2. Historical total landings of skates reported for subareas 10, 12 and 14 are presented in Figure 20.1. Landings data from this ecoregion are also collated by NEAFC, and further studies to ensure that these data are consistent with ICES estimates are required.

20.3.2 Discards

No information on the discarding of skates is available for recent years.

Nevertheless, information on discards from observers in the Azorean longline fishery was reported to the WGDEEP, from 2004 to 2010, (WD Pinho and Canha, 2011). The results showed that *Raja clavata* and 'common skate complex' were among the frequently caught and discarded elasmobranch species.

Discards are probably the result of management measures, particularly the TAC/quotas, minimum size and fishing area restrictions (zoning by fleet characteristics) rather than of the complete lack of market. Management has induced changes in fleet behaviour, expanding the fishing areas to more offshore seamounts and deeper strata. Fisheries occurring outside the ICES area to the south of the Azores EEZ may exploit the same stocks considered here.

20.3.3 Quality of catch data

Species-specific landings data are not currently available for skates landed in this ecoregion, however, more than 90% of the Azorean landings are estimated to be *R. clavata*.

20.3.4 Discard survival

Information on the discard survival of skates in these fisheries is not currently available.

20.3.5 Species composition

In the Azores, there is no systematic fishery/landing sampling programme for these species because they have low priority on the port sampling programme. Landings of skates and rays from Azorean fisheries are reported under generic categories. Accurate data on the composition of skates landed are not currently available.

20.4 Commercial catch composition

20.4.1 Length composition of landings

Length samples of *R. clavata* have been collected since 1990, however few individuals were sampled until 2004 (Figure 20.2; WD Pinho and Pereira, 2017). There are no data available for 2017, 2018, 2019 and 2020 (WD Pinho *et al*., 2019).

20.4.2 Length composition of discards

No information available.

20.4.3 Sex ratio of landings

No information available.

20.4.4 Quality of data

Only limited data are available. Improved data collation and quality checks (including for species identification) are required.

20.5 Commercial catch and effort data

No new information is available.

Relative indices of abundance for the thornback ray species were estimated in 2019 for the period 1990–2017 using a Generalized Linear Modelling approach with a hurdle (delta) model (WD08 Santos *et al*., 2020c) (Figure 20.3). The standardization protocols assumed a hurdle model (zero-altered lognormal) with a binomial error distribution and logit link function for modelling the probability that a null or positive observation occurs (proportion of positive catches), and a lognormal error distribution with an identity link function for modelling the positive catch rates on successful trips.

The trends from the nominal and standardized index differed substantially. Indeed, the nominal CPUE showed an oscillation over time, with an increasing trend from 2007–2015 and decreasing for 2016 and 2017, while the standardized index showed a more stable trend overall (Figure 20.3).

20.6 Fishery-independent surveys

An overview of the elasmobranch species occurring in Azorean waters and ICES Subarea 10, their fisheries and available information on species distributions by depth were described by Pinho (2005; 2014a, b WD), Pinho and Silva (2017 WD) and Santos *et al*. (2020a).

Since 1995, the Department of Oceanography and Fisheries (DOP) has carried out an annual spring demersal bottom longline survey (ARQDAÇO(P)-Q1) around the Azores. In the years 1998, 2006, 2009, 2014 and 2015, no survey was conducted (Pinho et al., 2020). The survey followed a stratified random sampling design in which each sampling area was divided into depth strata with 50 m intervals down to 1200 m depth. Each bottom longline set was deployed perpendicular to the isobaths. Catches per unit of effort were weighted by the corresponding area size to estimate the relative abundance indices (relative population number—RPN; ind. 10^{-3}hooks; Pinho *et al*., 2020) Due to the COVID-19 disruption, the bottom longline survey was not conducted in 2020 and thus there is a lack of fishery sampling data. Given there is no data for 2020, only data up to 2019 were used in the assessment. This survey is not specifically designed to catch elasmobranchs, and so does not provide quantitative information for most species.

Raja clavata is the only common species of skates and rays in this survey (Pinho *et al*., 2020). Only *Dipturus batis* and *Leucoraja fullonica* were caught in more than three longline set during 1996–2018 and their abundance was 20 to 100 times less than that of *R clavata*. Relevant biological information available from the survey was updated in 2019, including the annual abundance index (Figure 20.4) and length–frequency distribution (Figure 20.5). The survey abundance index series is calculated excluding the statistical area VI, corresponding to by western islands (Flores and Corvo), because this statistical area was not sampled in 1996 and 2008 (ICES, 2020).

The absence of records of the youngest size classes in this survey can be attributed to the gear selectivity (Figure 20.5). Catches of other skates are insufficient to be informative of stocks trends.

Information on elasmobranchs recorded on MAR is available from the literature (Hareide and Garnes, 2001) and was summarized in ICES (2005).

20.7 Life-history information

No new information is available. There is poor knowledge of the biology of the species for this ecoregion and available information is uncertain. The definitions of the appropriate set of life-history parameters for this group of species (that best describe population dynamics) and for this ecoregion should be addressed in future work in order to provide more accurate data for exploratory assessments.

20.8 Exploratory assessment methods

Length-based indicators (LBI)

Length-base indicators reported from WKLIFEV were explored for this exercise. The exercise was done for Fishery length composition from 2002–2016 and for the Azorean longline survey length compositions from 1995–2019 (discards were assumed to be negligible). In both scenarios were used pooled sexes for LBI exploratory analysis. Main life-history parameters used are resumed in Table 20.4. Computations were performed using R software and the codes were available in the GitHub library of ICES. Results from the analysis are shown in Figures 20.5–20.6 and Tables 20.5–20.6. Results show that for immature conservation a substantial harvesting occurs before maturity (Lc and L25%<Lmat). This was expected since the current relative exploitation pattern corresponds to a Lc < Lopt and Lmat.

For mature fraction of the population the results suggest that the large individuals are present and with a good conservation status (Lmax>Linf). The Lmat (77.9 cm) is considerably higher than Lopt (61.4 cm) and the results of Pmega indicator clearly suggest that the mega spawners in the fishery landings and Azorean longline survey are higher than 30% throughout the analysed period. However, it is important to note the two last years of the Azorean longline survey, the values of Pmega indicator were lower than 30%.

The MSY proxy results show that exploitation is below the MSY level (Lmean>Lopt and Lmean>LF=M), thus, the exploitation for this species is considered sustainable (Tables 20.5–20.6 and Figures 20.5–20.6).

No assessments have been conducted due to insufficient data.

20.9 Quality of assessments

Analyses of survey trends may be informative for *R. clavata* but do not allow the status of other skates to be evaluated.

20.10 Reference points

No reference points have been proposed for any of these species.

20.11 Conservation consideration

No new information.

20.12 Management considerations

The ecoregion is considered to be a sensitive area. The exploratory analysis demonstrated a sustainable exploitation for these species, but the fishing gear selectivity should be adjusted (increase the size of the hooks).

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Table 20.1. Skates and Rays in the Azores and Mid-Atlantic Ridge. Reported landings (t) from ICES subareas 10 and 12 for the period 1988–2004.

Year	Subarea 10				Subarea 12	Subarea 14
	Portugal (Azores)	France	Spain	Total	UK	UK
1988	48			48		
1989	29			29		
1990	35			35		
1991	52			52		
1992	43			43		
1993	32			32		
1994	55	1		56		
1995	62			62		
1996	71			71		
1997	99			99		
1998	117			117		
1999	103			109		
2000	83		24	107		
2001	68	2	29	99	1	+
2002	70			70	1	+
2003	89			89	6	
2004	72			72	1	

Table 20.2. Skates and Rays in the Azores and Mid-Atlantic Ridge. Reported landings of skates and rays (t) from ICES subareas 10, 12 and 14 for the period 2005–2020.

Year	Subarea 10			Subarea 12		Subarea 14			Total
	Portugal (Azores)	Spain	France	Spain	France	France	Norway	Germany	
2005	47		0.06	0	0.632			0	48
2006	62		0	0	0.029		6.6	0.2	69
2007	71		0	0	0.0135			0.1	71
2008	72		0.063	0	0.0031		0.7	0	73
2009	60		0.16	1.513	0.757		2.5	0	65
2010	68		0.066	5.106	0.275			0	74
2011	91		0.156	1.764	0.358			0	93
2012	103		0.002	0.671	0.26			0	104
2013	115		0.081	0.485	0			0	116
2014	187		0.03	2.481	0.189			0	190
2015	171		0	0	0.055	0.02	0	0	171
2016	127		0	0	0				127
2017	64		0	0	0			0	64
2018	62		0	0	0	0	0	0	61
2019	42		0	0	0	0	3	0	45
2020	60	0	0	0	0.1	0	0	0	60

Table 20.3. Skates and Rays in the Azores and Mid-Atlantic Ridge. Assessment summary. Relative abundance index (catch per unit effort weighted by the size of the strata) of thornback ray (*Raja clavata*) from the Azores (ICES Subarea 10.a2) from the Portuguese bottom longline survey (ARQDAÇO(P)-Q1).

Year	Abundance index	Lower	Upper
1995	10.2	4.5	16.9
1996	7	3.7	10.2
1997	5.1	3.2	6.7
1998	NA	NA	NA
1999	4.7	3.1	6.3
2000	4.0	1.53	6.9
2001	4.3	1.97	6.7
2002	17.2	10.4	25
2003	26	11.1	38
2004	13.4	9.1	18.3
2005	22	9	31
2006	NA	NA	NA
2007	18.0	9.8	27
2008	8.3	4.2	11.9
2009	NA	NA	NA
2010	7.3	4.6	9.9
2011	4.9	2.5	7.5
2012	6.6	4.4	8.9
2013	2.8	1.53	4
2014	NA	NA	NA
2015	NA	NA	NA
2016	3.7	2.3	5.1
2017	8.0	3.6	13.4
2018	4.1	2.3	5.9
2019	12	5.8	16.5
2020	NA	NA	NA

NA = not available.

Table 20.4. Input constant parameters used in LBI analysis for *Raja clavata* of the Azores (ICES Area 10.a.2).

Parameters	Value	Definition	Obs
Loo (cm)	92.16	Asymptotic average maximum length	Santos *et al*. (2021)
k (year^{-1})	0.104	Growth coefficient of the von Bertalanffy growth model	Santos *et al.* (2021)
Lmat (LT, cm)	77.9	Length at size first maturity	Santos *et al.* (2021)
M	0.16	Natural mortality	Santos *et al.* (2021)
M/k	1.55	Ratio of natural mortality and the von Bertalanffy growth coefficient	Santos *et al.* (2021)

Table 20.5. Skates and Rays in the Azores and Mid-Atlantic Ridge. Traffic light indicators for *Raja clavata* from the Azorean fishery landings for the period 2002–2016 (ICES Area 10.a.2).

		Conservation				Optimizing	MSY
		Lc / Lmat	L25% / Lmat	Lmax5% / Linf	Pmega	Lmean / Lopt	Lmean / LF=M
	Reference	> 1	> 1	> 0.8	> 0.3	~ 1 (> 0.9)	≥ 1
Bottom longline	2002	0.79	0.82	0.89	0.52	1.15	1.02
	2003	0.75	0.79	0.92	0.50	1.13	1.04
	2004	0.73	0.76	0.89	0.39	1.10	1.04
	2005	0.67	0.73	0.91	0.40	1.08	1.07
	2006	0.67	0.73	0.90	0.30	1.05	1.04
	2007	0.73	0.79	0.91	0.43	1.11	1.04
	2008	0.75	0.79	0.91	0.46	1.12	1.03
	2009	0.76	0.82	0.92	0.44	1.13	1.02
	2010	0.74	0.74	0.90	0.23	1.07	0.99
	2011	0.80	0.80	0.90	0.49	1.14	1.00
	2012	0.76	0.76	0.92	0.37	1.12	1.01
	2013	0.76	0.78	0.90	0.39	1.12	1.01
	2014	0.74	0.76	0.91	0.38	1.11	1.03
	2015	0.71	0.76	0.89	0.43	1.10	1.04
	2016	0.76	0.78	0.89	0.39	1.11	1.01

Table 20.6. Skates and Rays in the Azores and Mid-Atlantic Ridge.Traffic light indicators *for Raja clavata* from the Azorean spring bottom longline survey for the period 1995–2019 (ICES Area 10.a.2).

		Conservation				Optimizing Yield	MSY
		Lc / Lmat	L25% / Lmat	Lmax5% / Linf	Pmega	Lmean / Lopt	Lmean / LF=M
	Reference	> 1	> 1	> 0.8	> 0.3	~ 1 (> 0.9)	≥ 1
Survey	1995	0.67	0.71	0.87	0.23	1.03	1.01
	1996	0.75	0.80	0.92	0.37	1.10	1.01
	1997	0.94	0.87	0.92	0.75	1.27	1.00
	1998	0.67	0.75	0.95	0.40	1.10	1.08
	1999	0.58	0.62	0.92	0.31	1.02	1.09
	2000	0.48	0.67	0.91	0.41	1.04	1.24
	2001	0.52	0.67	0.93	0.43	1.03	1.18
	2002	0.56	0.60	0.82	0.11	0.90	1.00
	2003	0.57	0.62	0.82	0.11	0.92	1.01
	2004	0.64	0.69	0.85	0.13	0.98	1.00
	2005	0.74	0.75	0.89	0.26	1.07	1.00
	2006	0.66	0.69	0.90	0.21	1.03	1.03
	2007	0.67	0.71	0.88	0.14	1.02	1.00
	2008	0.78	0.80	0.98	0.42	1.15	1.03
	2009	0.67	0.73	0.94	0.22	1.05	1.04
	2010	0.89	0.79	0.91	0.52	1.22	1.00
	2011	0.69	0.74	0.92	0.31	1.07	1.04
	2012	0.80	0.76	0.92	0.51	1.15	1.01
	2013	0.76	0.79	0.92	0.57	1.18	1.07
	2014	0.69	0.76	0.94	0.49	1.13	1.10
	2015	0.69	0.76	0.94	0.49	1.13	1.10
	2016	0.88	0.75	0.94	0.53	1.24	1.03
	2017	0.61	0.71	0.90	0.34	1.05	1.10
	2018	0.69	0.74	0.88	0.30	1.07	1.04
	2019	0.69	0.70	0.82	0.09	1.00	0.98

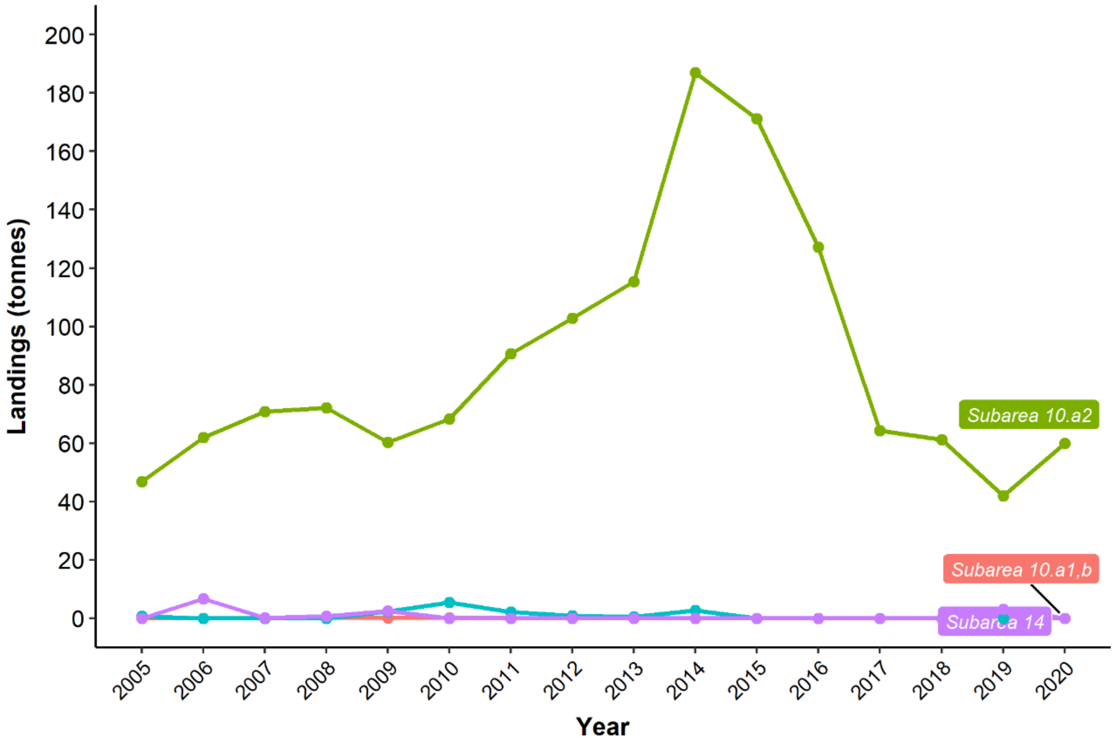

Figure 20.1. Skates and Rays in the Azores and Mid-Atlantic Ridge. Historical landings of skates and rays from Azores (ICES Division 10.a2) and MAR (ICES subareas 10, 12 and 14).

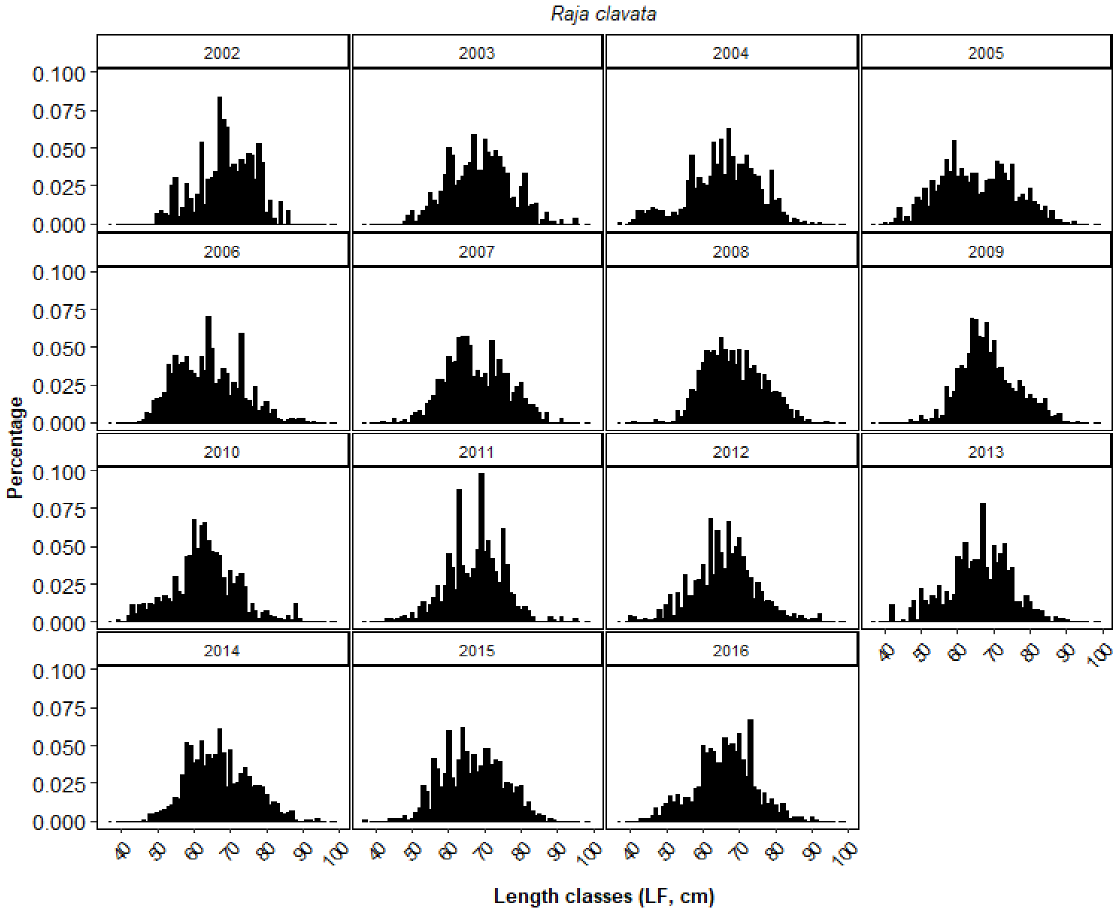

Figure 20.2. Skates and Rays in the Azores and Mid-Atlantic Ridge. Length-frequency of *Raja clavata* landed in the Azorean for the period 2002–2016.

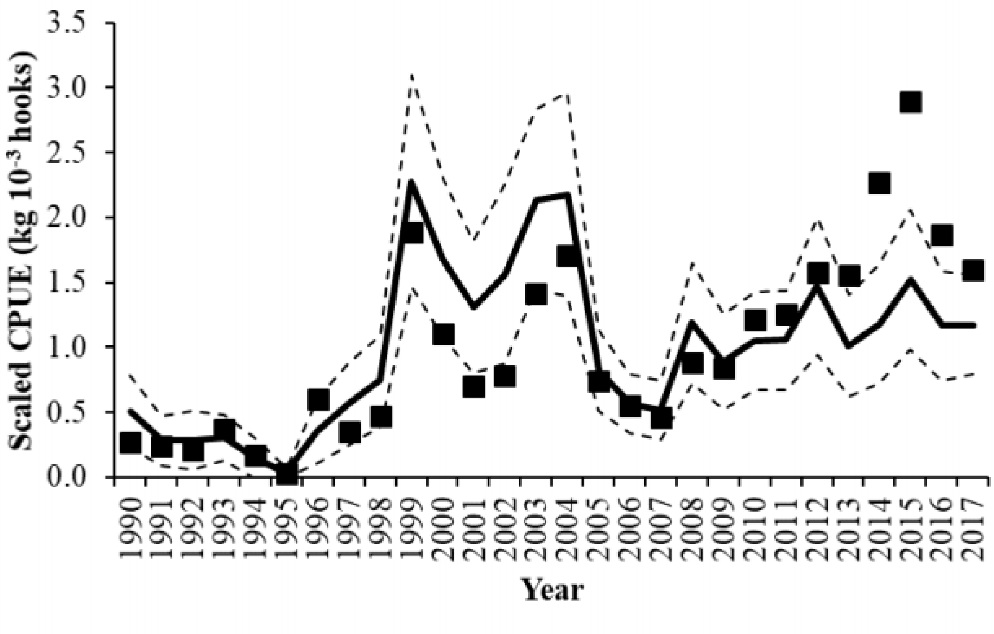

Figure 20.3. Skates and Rays in the Azores and Mid-Atlantic Ridge. Standardized fishery CPUE of *Raja clavata* landed in the Azorean for the period 1990–2017. Square points are observed nominal CPUE; Black line: Standardized CPUE and dashed lined 95% confidence interval.

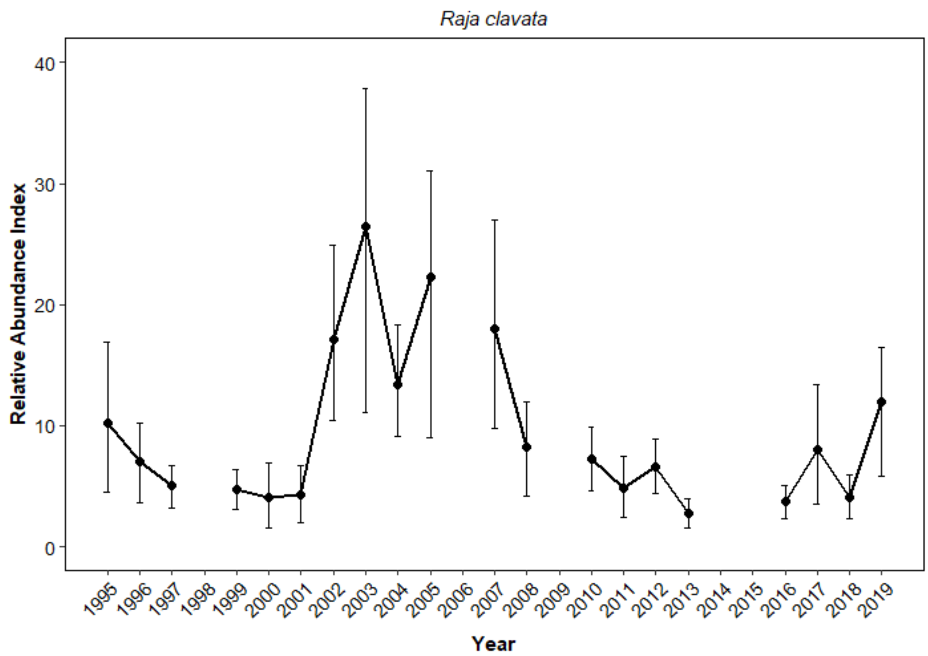

Figure 20.4. Skates and Rays in the Azores and Mid-Atlantic Ridge. Annual abundance, in numbers, of *Raja clavata* from the Azores (ICES subarea 10) from the Azorean demersal spring bottom longline survey (1995–2019).

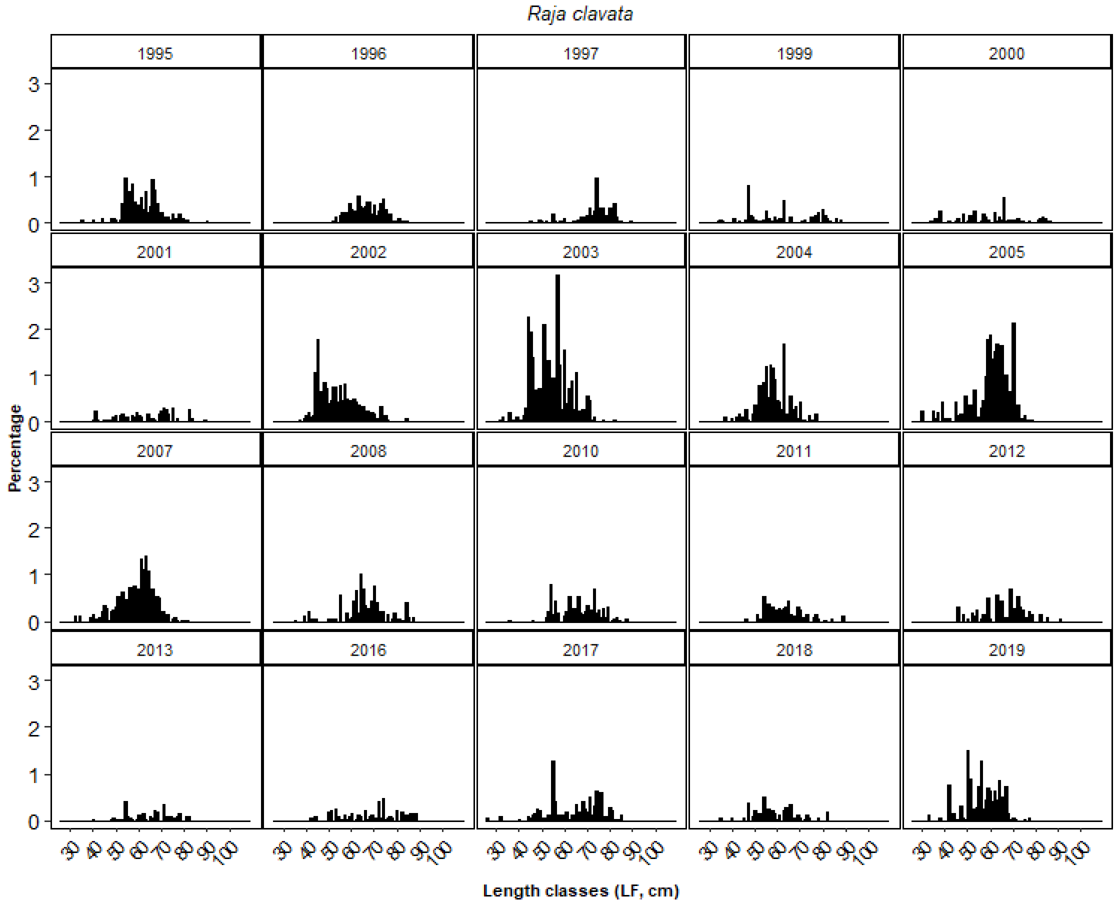

Figure 20.5. Skates and Rays in the Azores and Mid-Atlantic Ridge. Length-frequency of *Raja clavata* caught in the Azorean demersal spring bottom longline survey for the period 1995–2019.

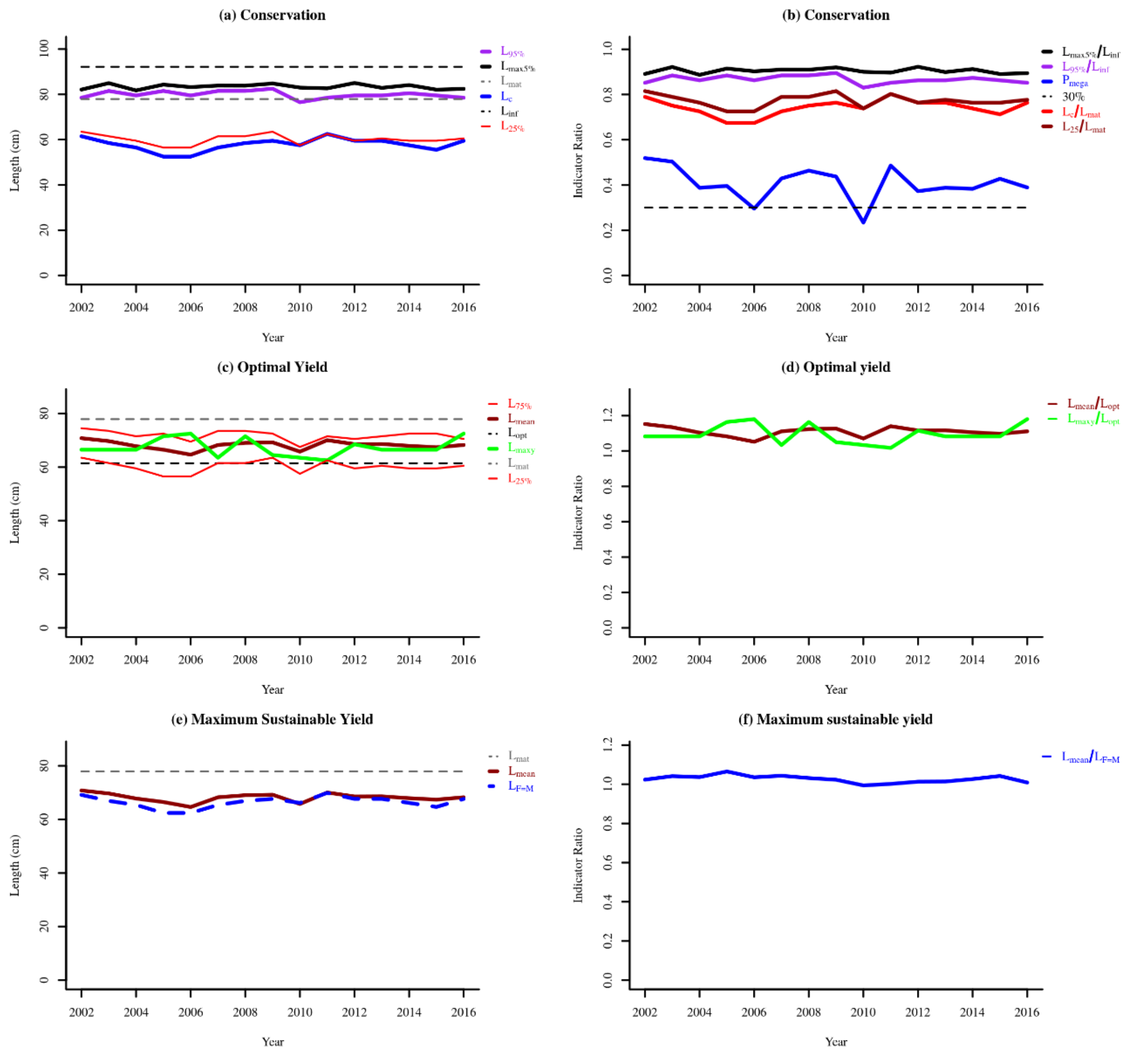

Figure 20.6. Skates and Rays in the Azores and Mid-Atlantic Ridge. Indicator ratios and reference points for *Raja clavata* from the Azorean fishery landings (2002–2016).

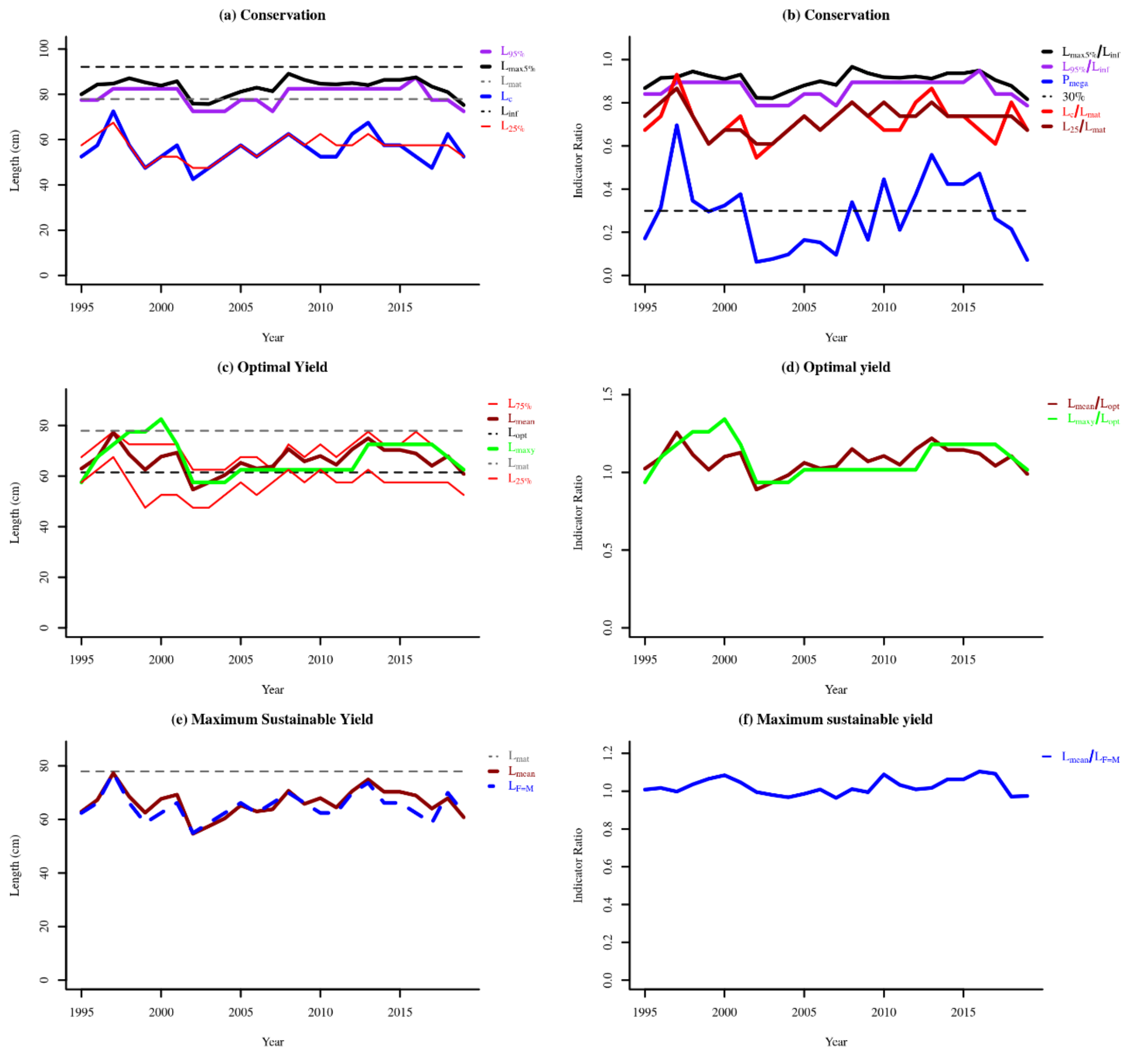

Figure 20.7 Skates and Rays in the Azores and Mid-Atlantic Ridge. Indicator ratios and reference points for *Raja clavata* from the Azorean longline survey (1995–2019).

21 Smooth-hounds in the Northeast Atlantic

21.1 Stock distribution

Three species of smooth-hound (Triakidae) occur in the ICES area.

Starry smooth-hound *Mustelus asterias*

This is the dominant smooth-hound in northern European waters. The development of molecular genetic identification techniques has allowed the reliable identification and discrimination of NE Atlantic *Mustelus* species (Farrell *et al*., 2009). Subsequent studies involving the collection of 231 *Mustelus* from the Irish Sea, Bristol Channel, Celtic Sea and west of Ireland, identified all to be *M. asterias* (Farrell *et al*., 2010a, b). Studies of *Mustelus* samples (n = 504) from the North Sea and English Channel (McCully Phillips and Ellis, 2015) also found all specimens to be *M. asterias*.

There are several on-going tag-and-release programmes for *M. asterias* (e.g. Burt *et al*., 2013 WD). Sportvisserij Nederland, in conjunction with Wageningen Marine Research, have a tagging programme with anglers in the Dutch Delta (Brevé *et al*., 2016, 2020). The latest study reported that 3699 *M. asterias* were tagged, and 220 recaptures reported (Brevé *et al*., 2020). Recapture positions showed a circannual migration, with fish spending the summer in the southern North Sea and overwintering in the English Channel and Bay of Biscay, suggesting a degree of philopatry (Brevé *et al*., 2016, 2020). These behaviours are supported by electronic tagging studies conducted by Cefas (Griffiths *et al*., 2020). Cooperative large-scale analyses of all available tagging data are required to further understand population stock structure of *M. asterias* in the Northeast Atlantic. Tagging studies from the more southern parts of the distribution range could usefully be undertaken.

In the absence of more detailed studies on stock identity, WGEF considers there to be a single biological stock unit of *Mustelus asterias* in the continental shelf waters of ICES Subareas 4, 6–8. The southern limits are uncertain.

Common smooth-hound *Mustelus mustelus*

This species occurs along the west coast of Africa, Mediterranean Sea and western Europe. It is believed to be the more common species in the southern parts of the ICES area, but the northern limits are uncertain. No confirmed specimens have been found in northern parts of the ICES area in recent years and historical records are questionable, especially those records north of the Bay of Biscay. Separating these two species on the presence or absence of spots is unreliable (Compagno *et al*., 2005; Farrell *et al*., 2009), and information and data from northern Europe referring to *M. mustelus* likely refers to *M. asterias*.

Black-spotted smooth-hound *Mustelus punctulatus*

This species occurs in the Mediterranean Sea (Quignard, 1972) and off NW Africa and the southernmost part of ICES Division 9.a is believed to be the northern limit of this species.

Generic issues

The species composition of smooth-hounds in Subareas 8–9 is unclear, and species/stocks in these areas likely extend into the northern part of the CECAF area and Mediterranean Sea. Given species identification issues and that some species and/or stocks may extend beyond the ICES area, the identification of management unit(s) would need appropriate consideration.

Given the problems in separating *M. asterias* and *M. mustelus* and that data for these two species are confounded, data in this chapter are generally combined at genus level. Whilst assessments conducted by WGEF are based on *Mustelus asterias*, management advice should be applied at the genus level, so as to avoid potential identification problems associated with management and enforcement.

21.2 The fishery

21.2.1 History of the fishery

Smooth-hounds are a seasonal bycatch in trawl, gillnet and longline fisheries. Though they are discarded in some fisheries, others land them as bycatch, depending on market demands. Some may also be landed to supply bait for pot fisheries.

Smooth-hounds are also a relatively important species for recreational sea anglers and charter boat fishing in several areas, with anglers and angling clubs often having catch-and-release protocols, particularly in the Celtic and North Sea ecoregions.

21.2.2 The fishery in 2020

The impact of the COVID-19 pandemic on fishing activity, though so far unquantified, may be assumed depending on national or local restrictions in place, to have reduced fishing effort in 2020.

Anecdotal information from the UK fishing industry suggests that increased landings of smooth-hounds in recent years are partly to supply market demand for 'dogfish', given the current restrictions on spurdog. *M. asterias* is also of increasing importance to some inshore fisheries, given restricted quotas for traditional quota stocks and anecdotal information suggests that, locally, the market value has increased beyond that of skates and rays.

21.2.3 ICES Advice applicable

ICES first provided advice for this stock in 2012 for 2013 and 2014 (which was reiterated for 2015), stating that "*Based on ICES approach to data-limited stocks, ICES advises that catches should be reduced by 4%. Because the data for catches of smooth-hounds are not fully documented and considered highly unreliable (due to the historical use of generic landings categories), ICES is not in a position to quantify the result*".

In 2015, ICES advised that "*when the precautionary approach is applied, landings should be no more than 3272 tonnes in each of the years 2016 and 2017*". This was based on a survey-based (Category 3) assessment, with the stock size indicator based on four survey indices.

In 2017, ICES advised that "*when the precautionary approach is applied, landings should be no more than 3855 tonnes in each of the years 2018 and 2019. ICES cannot quantify the corresponding catches*". This was based on a survey-based (Category 3) assessment, with the stock size indicator based on three survey indices.

In 2019, ICES advised that "*when the precautionary approach is applied, landings should be no more than 4626 tonnes in each of the years 2020 and 2021. ICES cannot quantify the corresponding catches*".

21.2.4 Management applicable

There are no specific management measures for smooth-hounds.

EC Council Regulations 850/98 for the `conservation of fishery resources through technical measures for the protection of juveniles of marine organisms' details the minimum mesh sizes that can be used to target fish. Although other dogfish (*Squalus acanthias* and *Scyliorhinus* spp.) could be targeted in fixed nets of 120–219 mm and >220 mm mesh size (in regions 1 and 2), *Mustelus* spp. would be classed under 'all other marine organisms', and so can only be targeted in fixed nets of >220 mm..

21.3 Catch data

21.3.1 Landings

No accurate estimates of catch are available for earlier years (Table 21.1; Figure 21.1), as many nations that landed smooth-hounds reported an unknown proportion of landings in aggregated landings categories (e.g. 'dogfish and hounds *nei'*).

ICES estimates, following WKSHARK2 (ICES, 2016a), indicate that landings have been over 3000 t since 2005 (Table 21.2). The main nations exploiting smooth-hounds are France and the UK. The English Channel and southern North Sea are important fishing grounds.

Although landings from Spain show a decrease since 2015, this is mostly due to unavailable data from FAO areas 34 and 37, which represented on average ca. 11% and 30% of total landings reported to WGEF for this country during 2005–2014, respectively.

Landings outside the FAO area 27 currently available to WGEF are considered negligible when accounting all countries combined data during 2005–2020 (ca. 0 to 2%).

Landings from the Netherlands show an increase in 2019–2020 which may be partially linked to an increase in fishing effort by fly shoot (seine) fisheries.

Species-specific landings for the various species of *Mustelus* are not considered accurate, and data have been collated at genus level. These values are likely underestimates, given that some nations still have some landings of 'dogfish and hounds *nei'*.

21.3.2 Discards

Although discards data are available from various nations, data are limited for some nations and fisheries. Seven countries reported preliminary estimates of discards for 2009–2020, however data show high inter-annual variability by country and thus, further data analysis should be undertaken if data to be used in the assessment (see also Section 1.14). Given the seasonality of catches in some areas, and that *M. asterias* is often taken by inshore vessels where observer data can be more sporadic, further studies to evaluate the most appropriate methods of raising data from observer trips to fleet level are required if catches are to be estimated appropriately.

In addition, discards data collection is likely to have been affected by COVID-19 national restrictions in place during 2020 (e.g. social distancing) hence, a decrease in the number of samples comparatively to previous years may be assumed, though the impact is yet to be quantified. Therefore, these data should be viewed with caution.

Earlier studies have indicated that juvenile *M. asterias* are often discarded (Figure 21.2), although the survival of these discards has not been evaluated (Silva and Ellis, 2019). *M. asterias* taken by beam trawl and *Nephrops* trawl were composed primarily of juveniles and sub-adults (<70 cm L_T), and nearly all were discarded. Gillnet catches were comprised primarily of fish 70–110 cm L_T, with fish <60 cm L_T usually discarded. Otter trawl catches covered a broad length range, and *M. asterias* <60 cm L_T were usually discarded. The absence of full retention at length in these gears may be due to various factors (e.g. catch quality and local market value) influencing the discarding behaviour of fishers.

Silva and Ellis (2019) also noted that a greater proportion of *M. asterias* were retained since landing opportunities for spurdog had become restrictive. In the years 2002–2009, the retention of *M. asterias* ≥70 cm L_T was 59% and 44% in gillnet and otter trawl fisheries, respectively. In the period 2010–2016, however, retention increased to 85% (gillnets) and 66% (otter trawl). In addition, length at retention for otter trawl dropped from 41 cm L_T (2002–2009) to 34 cm L_T (2010–2016).

WKSHARK3 undertook further exploratory analyses of discards data, with the discard-retention patterns described above again noted, and analyses of discards data from Scottish fisheries also presented (ICES, 2017).

21.3.3 Quality of catch data

Landings data have historically been of poor quality, as much of the landings data have been reported under generic landings categories. Most nations have made efforts to improve the recording of species in recent years.

Some northern European nations report more *M. mustelus* than *M. asterias* in official statistics, but WGEF combine these data, as *M. asterias* is the predominant and possibly the only species to occur around the British Isles.

Mustelus spp. are often taken in inshore fisheries, and landings data for vessels <10 m may not be complete.

M. asterias may be landed for bait in pot fisheries around the British Isles targeting whelk, and it is unclear whether such landings are reported consistently.

The availability of landings data from outside the ICES area (e.g. Mediterranean Sea) is limited, and the quality uncertain. In 2010, the European Commission collated landings data as an average across 2008–2010 and three species of *Mustelus* were represented in these data; *M. punctulatus* (269 t from Italy), *M. mustelus* (14 t combined from Italy, Spain, Malta and Slovenia) and *M. asterias* (1 t from Malta) (ICES, 2012). WGEF has not yet considered potential catches/landings for waters off NW Africa.

Better estimates of discarding are required, with information on discard survival also needed as a proportion of discarded *Mustelus* may survive.

21.3.4 Discard survival

Discard survival is variable across this family (Ellis *et al*., 2014 WD). Whilst quantitative data are limited in European waters, Fennessy (1994) reported at-vessel mortality of 29% for Arabian smooth-hound *Mustelus mosis* taken in a prawn trawl fishery. Mortality ranged from 57–93% for three triakid sharks taken in an Australian gillnet fishery, despite the soak times being <24 hours (Braccini *et al*., 2012). High survival of triakids has been reported in longline fisheries (Frick *et al*., 2010a; Coelho *et al*., 2012).

A UK research programme examining movements, behaviour and discard survival through electronic tagging of *M. asterias* found that in terms of at-vessel mortality, the longline fleet had the greatest proportion of fish in a lively condition (91%; primarily large individuals due to the selectivity of the gear), whilst gillnets had the highest mortality (56%) of the gears studied (McCully Phillips *et al*., 2019). Smaller individuals, which were caught mostly in beam trawls, were found to generally be in a poor condition (McCully Phillips *et al*., 2019).

21.4 Commercial catch composition

Studies to better understand the composition by size and sex (and species where there is spatial overlap) are required. Given the potential for sexual and sex-based segregation of *Mustelus*, as evidenced by sex-based dispersal of tagged fish (Griffiths *et al*., 2020), appropriate levels of monitoring would be required to fully understand catch composition over appropriate spatial and temporal scales.

21.4.1 Length composition of landings

In a UK study, 504 *M. asterias* samples (266 females; 238 males, Figure 21.3) were examined (McCully Phillips and Ellis, 2015), of which 286 (with a length range of 52–124 cm L_T) were landed by commercial vessels.

21.4.2 Length composition of discards

Silva and Ellis (2019) analysed the discard and retention patterns of *M. asterias* taken as bycatch in UK fisheries. Beam trawlers caught proportionally more juveniles (most records were of specimens of *ca.* 35–70 cm L_T), and discarding rates were high (95–99%). High rates of discarding (of smaller fish, <60 cm L_T) were also apparent in otter trawls, where about 63–71% of the total catches were discarded in the North Sea and Celtic Seas, respectively. Gillnets were more selective for larger fish (most fish were 60–100 cm L_T), and typically only larger fish (>70 cm L_T) were retained.

21.4.3 Sex ratio of landings

Of 286 commercially landed samples of *M. asterias* from the southern North Sea and eastern English Channel in May–November, 155 were female and 131 were male (McCully Phillips, unpublished). Due to *M. asterias* aggregating by sex and size, the sex ratio (and length–frequency) may vary over the year and between areas.

21.4.4 Quality of data

Mustelus length measurements may be collected as part of the concurrent sampling of the DCF. These data should be made available for future analysis.

21.5 Commercial catch and effort data

There are no data available.

21.6 Fishery-independent information

21.6.1 Availability of survey data

Several fishery-independent surveys operate in the stock area. They are often caught in GOV trawl and other otter trawl surveys in the area (Figure 21.4). For further details of trawl surveys in the stock area, see Section 15 (North Sea ecoregion), Section 18 (Celtic Seas) and Section 19 (Biscay-Iberia).

Larger individuals are not sampled effectively in beam-trawl surveys (because of low gear selectivity). For example, the UK western English Channel beam-trawl survey only occasionally records *M. asterias* >100 cm L_T (Silva *et al.*, 2020 WD; Figure 21.5).

Analyses of survey data need to be undertaken with care, as smooth-hounds are relatively large-bodied (the maximum size of *M. asterias* is at least 124 cm (McCully-Phillips and Ellis, 2015), with other sources suggesting they may attain 133 or 140 cm L_T) and adults may be strong swimmers, and able to avoid capture. As the largest individuals may not be sampled effectively in some survey gears, survey data may not sample the full length range effectively.

Given their aggregating nature, some surveys may have a large number of zero hauls and a few hauls with relatively large numbers, although this issue does not appear to be as pronounced as seen in spurdog.

Although two species of smooth-hound are often reported in surveys, the discrimination of these species was usually based on the presence or absence of spots, which is not a reliable characteristic. WGEF consider that survey data for these two species should be combined in any analyses, and that starry smooth-hound *M. asterias* is likely to be the only, or main, species in the Celtic Seas and North Sea ecoregions.

More detailed investigations of data in DATRAS undertaken by WGEF in 2017 indicate that data for *Mustelus* spp. and *Galeorhinus galeus* may have been confounded, with this most evident for Danish survey data (see Section 21.6.3), and so further analyses on the quality of IBTS-Q1 and IBTS-Q3 data could usefully be undertaken.

21.6.2 Survey trends

Updated survey data were examined by WGEF in 2021, as summarised below (see Section 21.9 for additional quantitative information).

IBTS-Q1 and IBTS-Q3

The IBTS surveys of the North Sea, undertaken in Q1 and Q3 by seven and six countries respectively, have a common time period of 30 years (1991–2020), and were included in the 2021 assessment. Both these surveys catch relatively low numbers of *M. asterias*, which may relate to smooth-hounds being more abundant in the more southern parts of the survey area. The long-term trend in abundance of smooth-hounds has increased over both the Q1 and Q3 time-series (Figure 21.6). The survey trends were updated in 2021 for the whole time series and will be averaged and treated as one following WKSKATE recommendation similarly to the skate stocks within the North Sea ecoregion (ICES, 2021b). Data presented for these surveys include all national data for Q1 and Q3 available on DATRAS, with the exception of Danish data for Q3 time-series as per issues described in Section 21.6.3.

EVHOE-WIBTS-Q4

This survey of ICES divisions 7.g–k and 8.a.b.d has a 23-year time-series of data (1997–2016, 2018–2020), and this survey was included in the assessment in 2021 (see Section 21.9), as it covers the south-western part of the stock area. Catch rates, though showing marked inter-annual variability, indicate a broadly increasing trend over the longer-term (Figure 21.7). The survey trends were updated for the whole time series in 2021, values may differ from previous results used in 2019 assessment as the new estimates used data available on DATRAS following methodology presented at WKSKATE (ICES, 2021b).

CGFS-Q4

This survey of ICES Division 7.d has a 24-year time-series of data (1997–2020), and this was included in the assessment in 2021 (see Section 21.9), as it covers part of the stock area in the eastern English Channel. Catch rates, though showing marked inter-annual variability, indicate a broadly increasing trend over the longer-term (Figure 21.7). Data considered for these estimations were based on data available on DATRAS, with calculations following methodology presented at WKSKATE (ICES, 2021b). This survey did not cover part of the survey grid in 2020 (ICES rectangles 29F1 and 30E9), however, data for 2020 were evaluated to better understand the potential impact in the assessment of this stock (see Section 21.9).

IGFS-WIBTS-Q4

This survey of ICES divisions 6.a and 7.b.g.j has a 16-year time-series of data (2005–2020), and this was included in the assessment in 2021 (see Section 21.9), as it covers the north-western part of the stock area. The increasing long-term trend in *M. asterias* is also evident in the Irish Groundfish Survey, although catch rates are generally low and more variable in recent years (2017–2020, Figure 21.10). This survey was previously used only as supporting information as it covers a shorter time-period in comparison to other surveys. However, following WKSKATE recommendations to increase the spatial coverage of the stock size indicator where deemed appropriated, further analyses were undertaken to include this survey in the assessment.

BTS-UK(E&W)-Q3 (in 7.afg[1])

This survey of ICES divisions 7.a and 7.f.g has a 28-year time-series of data (1993–2020), and catches reasonable numbers of *M. asterias*, albeit mostly immature specimens. This survey was not used in the 2021 assessment as the latter used survey indices of the exploitable biomass (individuals ≥ 50 cm L_T). The mean catch rate was derived from the catch rates from fixed stations (97 stations fished at least 24 years out of the 28-year time-series; Silva and Ellis, 2021 WD10). The temporal trend in CPUE (abundance and biomass for all individuals) indicate an increasing trend over the longer time series, though data indicate a decrease in 2018–2019. Both abundance and estimated biomass showed similar trends (Figure 21.9). Data are shown for 2020, however, these are considered not to be representative since these relate only to part of the survey area where this species is most abundant (ICES Division 7.f), and data for other parts of the survey area (where lower catches and more 'nil hauls' would be expected) are lacking (Silva and Ellis, 2021 WD10). The reduction in survey coverage in 2020 to only locations within ICES Division 7.f was due to the COVID-19 pandemic, with a total of 65 fixed stations used in the calculations in ICES Division 7.a and 7.g missed. While *M. asterias* is more commonly found in the Bristol Channel (7.f), there has been an increase in occurrence in the Irish Sea (7.a) in recent years compared to the early years of the time-series (Silva and Ellis, 2021 WD10).

BTS-Eng-Q3 (in 7.d and 4.c)

This survey of ICES divisions 7.d and 4.c has a 28-year time-series of data (1993–2020) and catches mostly juvenile *M. asterias*. It was not used in the 2021 assessment as the latter used survey indices of the exploitable biomass (individuals ≥50 cm L_T). The mean catch rate was derived from the catch rates from fixed stations (78 stations, Silva and Ellis, 2020b WD). The temporal trend in CPUE (abundance and biomass for all individuals) indicate an increasing trend over the longer time series, although CPUE is lower and more variable than recorded in the beam trawl survey of the Irish Sea and Bristol Channel (Figure 21.9). Survey indices for the whole time series were updated following on recommendations from WKSKATE (ICES, 2021b).

[1] Only one fixed (prime) station is within ICES Division 7.g (Prime 501). Also referred as UK(E&W)–BTS–Q3.

UK-Q1SWBEAM[2]

The UK beam-trawl survey in the western English Channel (7.e: 2006–2013), and more recently extended to cover the Celtic Sea (2014–2019) also encounters *M. asterias* (Figure 21.8). Analyses of these data (for the period 2006–2019) noted that 1098 specimens had been caught (713 ≥50 cm L_T for exploitable biomass calculations) accounting for 5% of the elasmobranch catch by numbers; the observed length range was 26–117 cm L_T (Silva *et al*., 2020 WD; Figure 21.5). In the western Channel (Division 7.e), the estimated total abundance and biomass showed similar trends, when considering all specimens and just fish of exploitable size, with peaks in 2009 and 2013–2014, and after a decrease in 2016, data suggest another abundance increase in 2018–2019 (Figure 21.8; Silva *et al*., 2020 WD). These results should be viewed as 'qualitative assessments', with further quantitative evaluations needed to better understand the utility of these trends for providing quantitative assessments and advice (Silva *et al*., 2020 WD).

Other surveys also capture *M. asterias.* Previous analyses of the UK (Northern Ireland) western IBTS Q4 survey of the Irish Sea indicated increasing catch rates, but recent data have not been analysed.

Although smooth-hounds are not usually subject to additional biological sampling in trawl surveys, UK (England and Wales) and IGFS surveys tag and release *M. asterias*, and the individual weights and sex (all fish) and maturity (male fish only) are recorded prior to release (See Section 21.7.5).

21.6.3 Data quality

Exploratory analyses of DATRAS data (numbers at length data, 1992–2017) indicated that there may be some confounding data for *Mustelus* and *Galeorhinus*, which could be due to taxonomic errors or coding errors.

Exploratory data checks indicated the minimum and maximum recorded sizes of *Mustelus* spp. in IBTS-Q1 were 24–129 cm L_T (1992–2017). While the record of 129 cm L_T is to a certain degree questionable, it is also potentially valid, given the range in the reported L_{max} for the species. All nations recorded a minimum size of free-living pups that was greater than the length of the smallest neonates recorded by McCully Phillips and Ellis (2015), and so are within the accepted range.

Exploratory data checks indicated the minimum and maximum recorded sizes of *Mustelus* spp. in IBTS-Q3 were 22–149 cm L_T (1992–2016). Once again, the minimum lengths observed by each nation (22–70 cm L_T) were all within acceptable limits. During 1992–2016 in IBTS-Q3 most nations caught *Mustelus* spp. to a maximum length of 97–110 cm L_T, with one vessel (DAN) recording specimens larger than 110 cm L_T, and to 149 cm L_T.

For IBTS-Q3, the length-distributions available for *Mustelus* on DATRAS during 1992–2016 indicate that only one vessel (DAN) reports *Mustelus* spp. >110 cm L_T (Figure 21.11), and further explorations of DATRAS data indicate that there seems to be inter-annual variation in the species of triakid sharks caught (for specimens >110 cm L_T; Figure 21.12). These preliminary analyses suggest that DATRAS data for *Mustelus* and *Galeorhinus* are confounded for DAN, and further analyses of these data are required, in order to determine whether it is a coding error or misidentification, and also to determine the extent of this issue.

[2] This survey may also be referred to as 'Q1SWECOS', 'Q1SWBEAM ', 'BTS-UK-Q1' in other ICES-related documents.

For stock assessment purposes in 2021, the IBTS-Q1 and IBTS-Q3 indices were both based on data held on DATRAS and, although IBTS-Q1 included data from all countries, IBTS-Q3 included data from all countries except Danish data.

Further analyses of the quality of DATRAS data indicate that there are also some relatively large catches, with most large catch events related to a single vessel. Further analyses of these data are also required.

The indices used in the assessment for EVHOE-WIBTS-Q4 in 2021 were calculated using data currently available on DATRAS whereas in 2019, these were calculated using data held in the national database. The main differences between the two datasets relate to 2009 and 2010, as data currently on DATRAS show no *Mustelus* caught contrary to the national database. However, this will not affect the ratio of the mean of the last two values (index A) and the mean of the five preceding values (index B) used in the assessment.

Although discussions during WKSKATE highlighted the importance of using DATRAS datasets instead of national databases, there are remaining discrepancies in species mapping on historical data within BTS-UK(E&W)-Q3 (in 7.afg) survey series on DATRAS (e.g. *Scyliorhinus stellaris*). Therefore, to make calculations similar across sharks and skate species (with the latter shown in Silva and Ellis, 2020a WD), survey indices here presented relate to national data (Silva and Ellis, 2021 WD10).

The indices used in 2017 for BTS-Eng-Q3 (in 7.d and 4.c) were calculated using the ICES DATRAS data product *CPUE per length per Hour and Swept Area*. During the WGEF meeting in 2019, an error was found within the DATRAS data product thus, survey indices in 2019 were calculated using data held in the national database (see Section 21.6 in ICES, 2020). In 2021, these indices were recalculated using DATRAS exchange data and presented at WKSKATE (ICES, 2021b). Although discrepancies between data held within DATRAS and national database may remain, recommendations from WKSKATE were followed and indices provided to WGEF 2021 used a selection of fixed (prime) stations within DATRAS exchange data. The stations chosen for the indices calculations were the same as if using data held within national database (Silva and Ellis, 2020b WD; ICES, 2021b).

21.7 Life-history information

Biological data are not collected under EU-MAP, although some *ad hoc* data are collected on fishery-independent surveys and there are some published studies resulting from biological investigations of *Mustelus* spp. in European seas, including from the NE Atlantic and Mediterranean Sea.

21.7.1 Habitat

The distribution of *Mustelus asterias* around the British Isles has been described, with more detailed studies on the habitat utilization undertaken for the eastern English Channel (Martin *et al*., 2010; 2012).

21.7.2 Spawning, parturition and nursery grounds

Mustelus asterias pups are taken in trawl surveys (including beam trawl surveys), and such data might be able to assist in the preliminary identification of pupping and primary nursery grounds. Most of the records for *M. asterias* pups recorded in UK beam-trawl surveys are from the southern North Sea, English Channel (including near the Solent) and Bristol Channel (Ellis *et al*., 2005).

Studies on other species of smooth-hound have shown high site fidelity of immature individuals on nursery grounds (Espinoza *et al*., 2011).

Recent biological studies have indicated that full-term pups of *M. asterias* range in size from 205–329 mm L_T and pup size was positively correlated with maternal length (McCully Phillips and Ellis, 2015; Figure 21.13). The smallest free-swimming neonate reported by this study was 24 cm L_T.

Parturition of *M. asterias* occurred in February in the western English Channel and June–July in the eastern English Channel and southern North Sea (Figure 21.14), indicating either protracted spawning or asynchronous parturition for the stock (McCully Phillips and Ellis, 2015).

21.7.3 Age and growth

Mustelus asterias

Farrell *et al*. (2010a) studied the age and growth in the Celtic Seas ecoregion. Growth parameters for males (n = 106) were L_∞ = 103.7 cm L_T, L_0 = 38.1 cm, k = 0.195 year^{-1}). Growth parameters for females (n = 114) were (L_∞ = 123.5 cm L_T, L_0 = 34.9 cm, k = 0.146 year^{-1}). Estimates of longevity were 13 years (males) and 18.3 years (females). The lengths-at-age for *M. asterias* based on these growth parameters are given in Table 21.3.

An analysis of samples collected in waters around the British Isles between 2009–2019 provides preliminary estimates of L_∞ = 94.6 cm for males (n = 159, L_T = 24–100 cm ages 0–14) and L_∞ = 130.1 cm females (n = 163, L_T = 28–124 cm ages 0–17) (Ellis *et al.*, 2019 WD), although it should be noted that this study had more fish at age 0. Further work is required to evaluate the estimated ages and, in terms of stock assessment modelling, the results of Farrell *et al.* (2010a) should still be used at the present time.

Mustelus mustelus

Age and growth have been reported for South African waters, with males and females estimated to mature at 6–9 and 12–15 years, respectively (Goosen and Smale, 1997). The maximum age reported in this study was 24 years.

21.7.4 Reproductive biology

Mustelus asterias

Studies in the Celtic Seas ecoregion indicated that the total length (and age) at 50% maturity for male and females are 78 cm L_T (4–5 years) and 87 cm L_T (six years), respectively (Farrell *et al.*, 2010b). A subsequent study, collected primarily from the southern North Sea and English Channel, estimated 50% maturity for males at 70.4 cm L_T (smallest mature = 65 cm; largest immature = 74 cm) and females at 81.9 cm L_T (smallest mature = 69 cm; largest immature = 87 cm) (McCully Phillips and Ellis, 2015; Figure 21.15). A recent analysis of samples collected between 2009–2019 by fishery-independent trawl surveys conducted by Cefas in waters around the British Isles estimated 50% maturity for males at 73.5 cm L_T (smallest mature = 64 cm; largest immature = 99 cm), with 100% maturity attained at ca. 90 cm, and females at 85.4 cm L_T (smallest mature = 75 cm; largest immature = 91 cm), with 100% maturity attained at ca. 92 cm (Ellis *et al.*, 2019 WD).

The smallest mature female that Farrell *et al*. (2010b) reported was 83 cm; considerably larger than the smallest females (69 cm and 75 cm L_T; summarised above) recorded by McCully Phillips and Ellis (2015) and Ellis *et al.* (2019 WD). This is interesting, as the studies use slightly different maturity keys, with Farrell *et al*. (2010b) assigning a female to be mature when oocytes were present, yellow, and countable at >3 mm in diameter, whereas the Cefas maturity keys (Table II of McCully Phillips and Ellis, 2015), which are comparable to those keys developed within ICES, assigned a female as mature when the oocytes are slightly larger (>5 mm).

Estimates of fecundity range from 8–27 (ovarian fecundity) and 6–18 (embryonic fecundity), with a gestation period of about twelve months (Farrell *et al*., 2010b), and there may also be a resting period of a year between pregnancies, giving a two-year reproductive period. Mature female specimens sampled by McCully Phillips and Ellis (2015) included seventeen late gravid females with term pups (uterine fecundity 4–20), which were found to have numerous yolk-filled follicles (n = 6–22; follicle diameters 6–10 mm). Further studies, including more samples of fish from winter and spring, are required to better gauge the reproductive period.

The number of mature follicles ranged from 0–28 in the mature females (McCully Phillips and Ellis, 2015). These will not all necessarily develop into embryos, however, and estimates of ovarian fecundity are known to exceed estimates of uterine fecundity. The size-spectra of the mature follicles (within mature females) ranged from 4.1 mm (mid-term gravid female) to 20.7 mm (mature female).

The uterine fecundity increased with total length and ranged from 4–20 (McCully Phillips and Ellis, 2015), which exceeded the maximum uterine fecundity (18) found by Farrell *et al*. (2010b), although they stated that their values may be underestimated due to females aborting pups on capture. The female identified with a fecundity of 20, was found with full-term pups. Furthermore, there were also positive linear relationships identified between maternal length and average pup length and weight (Figure 21.13; McCully Phillips and Ellis, 2015).

A combined dataset on uterine fecundity, using data from Henderson *et al.* (2003), Farrell *et al.* (2010b), McCully Phillips and Ellis (2015) and additional samples collected during fishery-independent trawl surveys conducted by Cefas is given in Table 21.4 (Ellis *et al.*, 2019). Of the 74 early- to late-gravid females in this combined study, the uterine fecundity ranged from 2–20 (mean = 8.5) which is similar to the initial studies of subsets of this combined dataset (summarised above). Uterine fecundity (F) had a linear relationship with L_T, as described by the equation $F = 0.28390.L_T - 19.18583$ (n = 74; $r^2 = 0.4295$; Figure 21.16).

In the Mediterranean Sea, *Mustelus asterias* reach maturity at about 75 cm (males) and 96 cm (females), with estimates of fecundity ranging from 10–45 (ovarian fecundity) and 10–35 (uterine fecundity), with fecundity increasing with length (Capapé, 1983), although it is possible the higher fecundity in this study may relate to data being confounded with other species of smooth-hound.

Mustelus mustelus

Studies in the Mediterranean Sea have found that females matured at 107.5–123 cm L_T (50% maturity at 117.2 cm) and that males matured at 88–112 cm L_T (50% maturity at 97.1 cm) (Saidi *et al*., 2008). This study also found that embryonic fecundity ranged from 4–18 embryos, with fecundity increasing with length. Further south off Senegal, the lengths at first (and 100%) maturity for *M. mustelus* were found to be 82 cm (95 cm), for males, and 95 cm (104 cm) for females (Capapé *et al*., 2006). This study reported litters of 4–21 pups.

21.7.5 Movements and migrations

Mustelus asterias

Although the movements and migrations of *M. asterias* are not fully known, there have been relatively high numbers tagged and released during various elasmobranch research programmes (e.g. Burt *et al*., 2013 WD, Ellis *et al*., 2019 WD). A tagging programme (2011–2014) undertaken by Sportvisserij Nederland, in conjunction with Wageningen Marine Research, involved anglers tagging *M. asterias* in the Dutch Delta. There were 2244 releases, of which 80 recaptures were reported (Figure 21.18; Brevé *et al*., 2016). Recapture positions indicated annual migrations between summertime grounds in the southern North Sea and overwintering in the English Channel and Bay of Biscay, suggesting a degree of philopatry (Brevé *et al*., 2016). This is an on-going tagging programme, and more recently Brevé *et al*. (2020) reported that during 2011–2019 a total of 3699 starry smooth-hounds were released, of which 220 recaptures were reported (ca. 5.9% return rate). The recent results support previous work from Brevé *et al*. (2016).

Cefas have tagged-and-released specimens of *M. asterias* from fishery-independent trawl surveys since 2003 (Burt *et al*., 2013). In 2019, a total of 1613 (744 females and 868 males, one unsexed) had been tagged and released, of which 40 (2.48%) have been recaptured and details returned (Ellis *et al*., 2019 WD). Results suggest that the species is wide ranging in northern European seas and displays seasonal migrations, which are likely related to its reproductive cycle (Figure 21.17; Ellis *et al*., 2019 WD). An electronic tagging programmes initiated by Cefas in 2017–2019 deployed 125 tags with a return rate of 14.4% to date. On a broad-scale, sex-biased dispersal and potential metapopulation-like stock structuring either side of the UK continental shelf was seen along with a clear diel variation in vertical activity and association with the seabed at the finer-scale (Griffiths *et al*., 2020).

21.7.6 Diet and role in ecosystem

Mustelus asterias is primarily carcinophagous (98.8% percentage of index of relative importance, %IRI), with the two main prey species being hermit crab *Pagurus bernhardus* (34% IRI) and flying crab *Liocarcinus holsatus* (15% IRI) in specimens from the Northeast Atlantic (McCully Phillips, *et al*., 2020). Ontogenetic dietary preferences showed that smaller individuals [20–69 cm total length (L_T)] had a significantly lower diversity of prey than larger individuals (70–124 cm L_T) and similarly, specimens from the North Sea ecoregion had a lower diversity of prey types for a given sample size than fish from the Celtic Seas ecoregion (McCully Phillips, *et al*., 2020). This study did not find any fish remains in the examination of 640 stomachs, however Ford (1921) and Ellis *et al*., (1996) found that teleosts were only eaten occasionally by larger individuals. Larger individuals can be important predators of commercial crustaceans, feeding on velvet swimming crab *Necora puber* and small edible crab *Cancer pagurus* (McCully Phillips, *et al*., 2020).

Other studies on the feeding habits of *Mustelus* also indicate a high proportion of crustaceans in the diet (Morte *et al*., 1997; Jardas *et al*., 2007; Santic *et al*., 2007; Saidi *et al*., 2009; Lipej *et al*., 2011).

The trophic level of specimens from the Northeast Atlantic was calculated as 4.34 when species-level prey categories were used; a value higher than previously indicated by other studies (Cortés, (1999; 3.7), Cotter *et al*. (2008; 3.9), and Pinnegar *et al*. (2002; 4.0)) due to the high tropic levels of their preferred crustacean prey species (McCully Phillips, *et al*., 2020). This will have ramifications for food web and ecosystem modelling, with the role of this species potentially underestimated to date.

21.7.7 Conversion factors

The relationship between total length and weight in the smooth-hounds sampled by McCully Phillips and Ellis (2015) are summarised below by sex and maturity stage (see also figures 21.20 and 21.21).

The relationship for males differed slightly to that of females, largely driven by the larger maximum length of females and the weights of females about to give birth. Of note is the 119 cm outlier, which was a post-partum female with a very low body mass. Samples of the smaller size classes were obtained from scientific trawl surveys, while the larger individuals were commercially-landed specimens.

Relationship $Y = ax^b$	Sex/Stage	a	b	r^2	n
Total weight to total length	All females	0.0014	3.2	0.992	248
	All males	0.0020	3.1	0.995	237
	Immature female (stage A/B)	0.0020	3.1245	0.994	170
	Immature male (stage A/B)	0.0014	3.2159	0.991	113
	Mature female (including early gravid) (stage C/D)	0.0021	3.1396	0.913	54
	Mature male (stage C/D)	0.0077	2.8084	0.938	123
	Mid-/late-term gravid females (stage E/F)	0.0002	3.7072	0.935	21
Gutted weight to total length	Sexes combined	0.0014	3.1580	0.995	484
	Female	0.0016	3.1	0.994	249
	Male	0.0014	3.2	0.996	235

Recent data on overall length-weight relationships for male and female *M. asterias* caught between 2009–2019 by Cefas fishery-independent trawl surveys around the British Isles are illustrated in Figure 21.19.

21.8 Exploratory assessment models

21.8.1 Previous studies

No previous assessments of NE Atlantic smooth-hounds have been made. However, there have been assessment methods developed for the Australian species *Mustelus antarcticus* (e.g. Xiao and Walker, 2000; Pribac *et al.*, 2005) which may be applied to European species when relevant data are available.

21.8.2 Data exploration and preliminary assessments

An analytical age-, sex-, and length-structured assessment model was explored for *M. asterias* following the approach of De Oliveira *et al.* (2013) for spurdog, however, further work is required.

21.9 Stock assessment

No quantitative stock assessment is available yet.

Since 2015, the stock of *M. asterias* in northern Europe was evaluated using trends from fishery-independent trawl surveys, as these are the longest time-series of standardised species-specific data available.

The biomass trends of the long-term time-series of three different surveys covering a proportion of the species distribution range were used in the 2019 assessment (IBTS-Q1, IBTS-Q3 and EVHOE-WIBTS-Q4). Following WKSKATE recommendation to investigate the expansion of the spatial coverage of Category 3 stock size indicators where considered appropriate (ICES, 2021b), further investigations were conducted during WGEF on the data available for *Mustelus* spp. from two additional GOV surveys (IGFS-WIBTS-Q4 and CGFS-Q4). These surveys were considered more effective at sampling larger specimens than beam trawl surveys (see below).

IBTS-Q1 and IBTS-Q3

Data from the two North Sea IBTS were used (see Section 15 for further details). These surveys sample the more northerly parts of the stock area. The biomass index of specimens ≥50 cm L_T of *Mustelus* spp. was used, though the GOV samples mostly larger fish (Figure 21.6). Data from Denmark were excluded in analyses for the IBTS-Q3, due to the suspicion that data for *Mustelus* and *Galeorhinus* were confounded (see Section 21.6.3). The temporal trends in abundance, total biomass and exploitable biomass (specimens ≥50 cm L_T) all showed similar patterns (Figure 21.6).

EVHOE-WIBTS-Q4

A biomass index of specimens ≥50 cm L_T of *Mustelus* spp. from the EVHOE-IBTS-Q4, was included in 2021, as this survey covers more south-western parts of the stock area (divisions 8.a.b.d; Figure 21.7). Data were available for 1997–2020 (excluding 2017) and indicate an increasing total and exploitable biomass. The total biomass was calculated using the weight from on-board catch weight per species, as no individual weight is available for most of the years. Exploitable biomass (specimens >50 cm L_T) was calculated using the length-weight relationship with $W_T = 0.0016 \cdot L_T^{3.1753}$.

CGFS-Q4

A biomass index of specimens ≥50 cm L_T of *Mustelus* spp. from the CGFS-Q4, was included in 2021, as this survey covers the eastern English Channel part of the stock area (Division 7.d; Figure 21.7). Data were available for 1997–2020 and indicate an increasing total and exploitable biomass. However, in 2020 the survey did not cover part of the survey grid (ICES rectangles 29F1 and 30E9). Consequently, four scenarios were run to evaluate the overall impact on the stock size indicator:

1. CGFS-Q4 time series excluded;
2. CGFS-Q4 included for the whole time series (1997–2020) and all available survey data;
3. CGFS-Q4 included for 1997–2019 with 2020 data excluded;
4. CGFS-Q4 included for the whole time series (1997–2020) excluding data from survey stations in ICES rectangles 29F1 and 30E9.

Results show that in all four scenarios there would be an increase in the stock size indicator. However, if excluding the CGFS-Q4 time series (scenario 1) the increase would be less pronounced comparatively to the other three scenarios (Table 21.6). The remaining scenarios show negligible impact on the overall stock size indicator thus, the EG agreed to use all data available for this survey time-series in the assessment (Table 21.6, Figure 21.25).

IGFS-WIBTS-Q4

Although the inclusion of this survey reduces the common time frame from 1997–2020 to 2005–2020, it covers the north-western parts of the stock area (divisions 6.a and 7.b.g.j) hence, was used in 2021 assessment. The biomass index of specimens ≥50 cm L_T of *Mustelus* spp. was used, though the GOV samples mostly larger fish (Figure 21.6). Data were available for 2005–2020 and indicate an increasing total and exploitable biomass, though more variable in recent years (Figure 21.10).

BTS-UK (E&W)-Q3 and BTS-Eng-Q3

These surveys sample juvenile *M. asterias* primarily, and so in 2021 were excluded from the assessment and advice. Data from 1993–2016 indicate that the abundance of pups has increased over the time series in the Irish Sea/Bristol Channel (BTS-UK(E&W)-Q3), but has been more stable in the eastern English Channel and southern North Sea (BTS-Eng-Q3) (Figure 21.23). Further analyses of these data are required, as it may be possible to develop an index of recruitment from such surveys. Other beam trawl surveys could also benefit from further appraisal in terms of *Mustelus* occurrence, spatial distribution and length frequency distribution and their potential suitability to provide further information.

Summary

The stock size indicator is based on 'exploitable biomass' (individuals ≥50 cm total length). The inclusion of additional surveys such as the IGFS-WIBTS-Q4, truncates the common time period from 1997–2020 to 2005–2020, however, it does extend the range of spatial coverage in relation to the stock distribution. IBTS-Q1 and IBTS-Q3 were averaged prior to standardised in relation to the long-term mean for the common time period (2005–2020) and thus, treated as a single survey following recommendations from WKSKATE (ICES, 2021b). The remaining three survey indices were also standardised in relation to their long-term mean for the common time period (2005–2020). The average of the four surveys was used to derive an annual index of stock size. In 2017, EHVOE-WIBTS-Q4 did not occur and the average for the annual index of stock size was based on the other surveys. All four surveys were given equal weighting. The mean index for the years 2019–2020 was 1.76, whilst the mean index for the preceding five years (2014–2018) was 1.42, with the most recent 2-year period being 1.24 times that of the preceding 5-year period (Figure 21.22; Table 21.5). CGFS-Q4 in 2020 was included in 2021 assessment as reduction in the survey area has shown negligible impact on the index ratios (Table 21.6, Figure 21.25).

Further studies to better quantify differences between 'total biomass' and 'exploitable biomass' are still to be undertaken. Such work could usefully be appraised during a dedicated workshop for smooth-hounds *Mustelus* spp. and tope *Galeorhinus galeus* as recommended during WKSKATE (ICES, 2021b). Furthermore, the suitability of statistical modelling to provide a single survey index and associated confidence intervals, similar to work developed for spurdog during the benchmark in 2021 (ICES, 2021a), could usefully be examined for *Mustelus*. This would allow for the potential use of multiple surveys while accounting for potential differences (e.g. season, design, gear, depth, sex, length class).

21.10 Quality of the assessment

Commercial landings data are available for recent years but may be compromised by poor data quality. Whilst fishery-independent trawl surveys provide the best time-series information, such surveys may under-represent the largest size classes. It is unclear as to how recent increases in CPUE may relate to increased stock abundance and/or a possible northward shift in distribution.

The positions of survey hauls containing smooth-hounds in the EVHOE-WIBTS-Q4 survey were plotted over the 1997–2019 time-series (Figure 21.24). The number of stations catching smooth-hounds increased over the survey, but the distribution of the catches has remained constant, occurring north of 46°N. There was no evidence from this survey to support the theory of a northward shift in the distribution, which would support the suggestion that increasing catch rates reflect population growth.

21.11 Reference points

No reference points have been determined for this stock.

21.12 Conservation considerations

The most recent IUCN Red List Assessment for European marine fishes (Nieto *et al*., 2015) upgraded all three *Mustelus* spp. to either Near Threatened (*M. asterias*) or Vulnerable (*M. mustelus* and *M. punctulatus*), identifying them as of increasing conservation interest. These species were listed previously as either Data Deficient or Least Concern (Gibson *et al.*, 2008).

21.13 Management considerations

Smooth-hounds appear to be increasing in relative abundance in trawl surveys, and in commercial landings data. Given the potential expansion in fisheries for smooth-hounds (which may reflect an increased abundance and that fishing opportunities for *S. acanthias* are limited), further studies to understand the dynamics, distribution and geographic boundaries of this stock are required.

Smooth-hounds taken by beam trawl are primarily juveniles and subadults (<70 cm L_T), and these are often discarded, as are smooth-hounds <50 cm L_T in otter trawl fisheries. Discard survival has not been quantified for many metiers, and survival is variable in this family (Ellis *et al*., 2014 WD). Further studies on the at-vessel mortality and post-release mortality, including of juveniles, are needed.

Survey data are available, and the quality of landings data is thought to be improving. Whilst there have been several recent biological investigations (Farrell *et al*., 2010a, b; McCully Phillips and Ellis, 2015), there is still uncertainty in some key biological parameters, including the duration of the reproductive cycle.

Smooth-hounds are also an important target species in some areas for recreational fisheries; though there are insufficient data to examine the relative economic importance of these fisheries, or the degree of mortality associated with recreational fisheries.

Other species of smooth-hound are targeted elsewhere in the world, including Australia/New Zealand and South America. Although smooth-hounds are generally quite productive stocks (relative to some other elasmobranchs), evidence from these fisheries suggests that various management controls can be appropriate.

21.14 References

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Table 21.1. Smooth-hounds in the Northeast Atlantic. Reported species-specific landings (t) for the period 1973–2014. These data are considered underestimates as some smooth-hounds are landed under generic landings categories. Species-specific landings data are not available for the Mediterranean Sea and are limited for the north-west African waters. Data from 2005 are lower than reported to ICES (2016a) and are considered underestimates (see Table 21.2 for recent estimates of landings 2005–2016).

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Belgium	.	.	.	.	.	.	.	.	.	.	.	.	.	
France	0	0	0	0	0	0	32	0	0	222	218	66	143	167
Netherlands	.	.	.	.	.	.	.	.	.	.	.	.	.	-
Portugal	.	.	.	.	.	.	.	.	.	.	.	.		-
UK -E, W & NI	0	0	0	0	0	0	0	0	0	0	0	0	0	0
UK - Scotland	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	32	0	0	222	218	66	143	167

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Belgium													
France	119	64	117	126	93	90	102	138	145	228	187	197	0
Netherlands	.	.	.	.	.	.	.	.	.	.	.	.	
Portugal													
UK -E, W & NI	0	0	0	0	0	0	0	0	0	0	0	0	0
UK - Scotland	0	0	0	0	0	0	0	0	0	0	0	0	0
	119	64	117	126	93	90	102	138	145	228	187	197	0

Table 21.1. (continued). Smooth-hounds in the Northeast Atlantic. Reported species-specific landings (t) for the period 1973–2014. These data are considered underestimates as some smooth-hounds are landed under generic landings categories. Species-specific landings data are not available for the Mediterranean Sea and are limited for the north-west African waters. Data from 2005 are lower than reported to ICES (2016a) and are considered underestimates (see Table 21.2 for recent estimates of landings 2005–2016).

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Belgium	.	.	.	.	.	.	.	.	.	.	.	.	8	10	1
France	306	377	585	589	682	767	714	908	522	926	969	706	2695	2955	2825
Netherlands	.	.	.	.	.	.	.	.	.	.	8	3	11	20	15
Portugal	.	.	.	.	.	.	.	.	.	.	.	35	42	41	187
Spain	.	.	.	.	.	.	.	.	.	.	34	48	9	83	14
UK -E, W & NI	14	0	0	0	0	0	0	0	115	132	161	919	337	323	647
UK - Scotland	0	0	0	0	0	0	0	0	0	1	0	-	-	-	-
	320	377	585	589	682	767	714	908	637	1059	1172	1712	3101	3433	3690

Table 21.2 Smooth-hounds in the Northeast Atlantic. ICES estimated landings (t; 2005–2020), based on data provided in the ICES Data Call (see ICES, 2016a). Blank = no data reported; 0 < 0.5 tonnes. Data revised in 2021.

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Belgium									1	1	1	3	2	1	1	3
Germany															1	
Denmark												0	0	1	0	0
Spain*	112	134	138	200	297	129	106	120	80	70	42	40	43	38	30	41
France	2685	2722	2958	3403	3082	3204	3241	2821	2942	2836	2963	2855	2730	3136	2934	2665
UK	171	130	155	171	199	275	315	339	325	331	303	469	376	390	474	405
Ireland			0	1	0	0	0			0	0					
Netherlands					4	9	3	23	26	24	24	22	22	34	74	91
Portugal	44	57	57	41	45	38	43	42	41	17	15	18	55	51	53	64
Total**	3013	3043	3308	3816	3628	3655	3709	3345	3415	3280	3349	3407	3228	3651	3567	3177

*** Data not available for Area 34 and 37 in 2015–2020; ** Includes negligible landings reported to Fishing Area 34 and 37 (ca. 0.0-2.4% of the total annual estimated landings).**

Table 21.3. Smooth-hounds in the Northeast Atlantic. Age-length key for *Mustelus asterias*, based on data given in Farrell *et al.* (2010a).

Age	Total length (cm)	
	Male	Female
0	38.1	34.9
1	49.7	46.9
2	59.3	57.3
3	67.2	66.3
4	73.6	74.1
5	79.0	80.8
6	83.3	86.6
7	86.9	91.6
8	89.9	95.9
9	92.4	99.7
10	94.4	102.9
11	96.0	105.7
12	97.4	108.1
13	98.5	110.2
14	99.4	112.0
15	100.2	113.6
16	100.8	114.9
17	101.3	116.1
18	101.7	117.1

Table 21.4 Smooth-hounds in the Northeast Atlantic. Fecundity at length data for *Mustelus asterias*, based on data given in Henderson *et al.* (2003), Farrell *et al.* (2010b), McCully Phillips and Ellis (2015) and Ellis *et al.* (2019 WD).

Source	Total length (cm)	Uterine fecundity	Maturity stage[3]
Henderson *et al.* (2003)	87	10	D
	89	2	D
	109	10	D
Farrell *et al.* (2010)	83	6	
	90	8	
	91	7	
	92	4	
	94	7	
	97	6	
	97	9	
	100	9	
	103	14	
	104	7	
	106	7	
	106	11	
	108	10	
	111	18	
	112	9	
McCully Phillips & Ellis (2015)	80	4	D
	83	7	D
	86	10	E
	88	9	D
	90	7	D
	91	6	F
	92	6	D
	93	4	F
	96	14	F
	97	9	F
	97	5	E
	97	11	D
	98	10	F
	98	10	D
	101	7	F
	101	11	E
	101	10	F
	101	12	D
	102	11	F

[3] Maturity stage as per described in McCully Phillips and Ellis, 2015.

Source	Total length (cm)	Uterine fecundity	Maturity stage[3]
	103	12	F
	104	13	F
	105	17	F
	105	8	F
	106	11	F
	110	17	F
	115	12	F
	116	20	F
	116	15	E
	124	13	F
Cefas unpublished[4] in Ellis *et al.* (2019 WD)	101	5	F
Cefas (Ciro 2/02) in Ellis *et al.* (2019 WD)	88	4	D
	92	2	D
	93	2	D
	101	9	F
	111	14	F
Cefas trawl surveys (CEnd 2/13) in Ellis *et al.* (2019 WD)	93	4	F
	97	10	E
Cefas trawl surveys (CEnd 4/18) in Ellis *et al.* (2019 WD)	81	3	F
	85	5	F
	87	4	F
	88	4	F
	89	5	F
	89	5	F
	90	4	F
	90	6	F
	91	7	E
	93	8	F
	97	10	F
	99	9	F
	100	12	F
	101	4	F
Cefas trawl surveys (CEnd 3/19) in Ellis *et al.* (2019)	82	6	F
	99	10	F
	100	12	F
	100	9	E
	108	2	D

[4] April 2019, 101 cm, 3671 g total weight

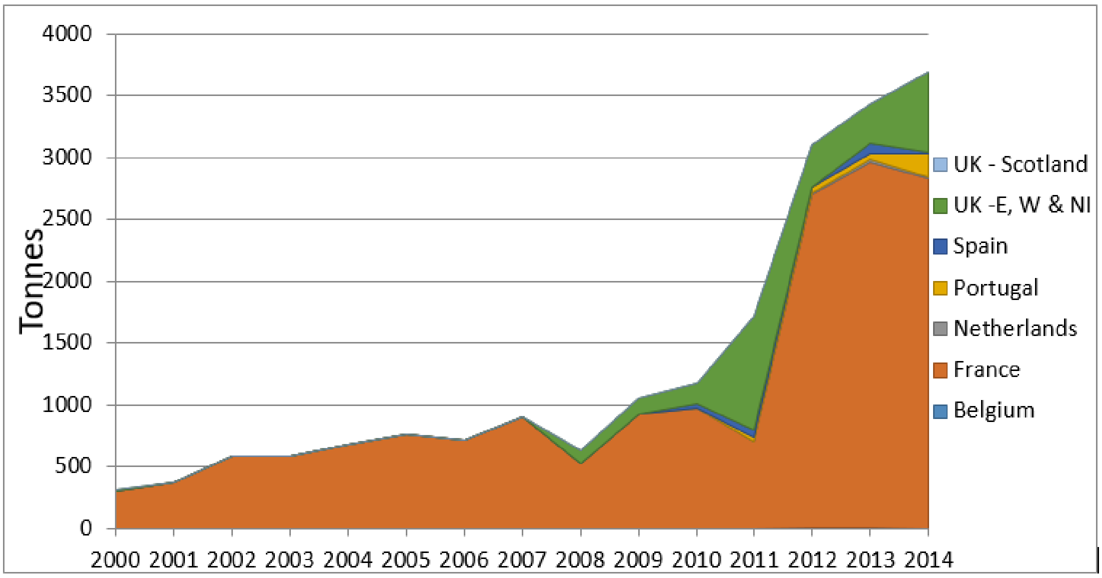
Table 21.5 Smooth-hounds in the Northeast Atlantic. Biomass indices for exploitable biomass (individuals of ≥ 50 cm total length) of starry smooth-hound derived from five surveys (average of NS–IBTS–Q1 and NS–IBTS–Q3, EVHOE–WIBTS–Q4, CGFS–Q4 and IGFS–WIBTS–Q4). The stock size indicator is the annual mean of the normalized surveys indices (2005–2020).

Year	NS–IBTS–Q1 Q3	EHVOE–WIBTS–Q4	CGFS–Q4	IGFS–WIBTS–Q4	Stock size indicator
2005	0.179	0.39	0.72	0.21	0.37
2006	0.52	0.196	1.00	0.26	0.49
2007	1.23	0.59	0.82	0.44	0.77
2008	0.62	1.23	1.01	0.37	0.81
2009	0.60	0.00	1.38	0.40	0.60
2010	0.69	0.00	0.82	0.75	0.57
2011	0.70	0.89	0.60	0.33	0.63
2012	0.74	0.84	0.75	0.61	0.73
2013	0.95	0.27	0.75	0.57	0.63
2014	1.24	1.14	0.57	1.02	0.99
2015	0.62	2.20	1.74	1.59	1.53
2016	0.86	1.99	1.09	2.20	1.54
2017	1.87	NA	0.97	2.50	1.79*
2018	1.08	1.79	0.67	1.41	1.24
2019	2.20	1.69	1.76	2.40	2.00
2020	1.86	1.85	1.34**	0.92	1.49

*** In 2017, the stock size indicator does not include EHVOE–WIBTS–Q4 (Data not available).**
**** Only parts of the survey area covered during CGFS–Q4 though impact considered to be negligible for starry smooth-hound.**

Table 21.6 Smooth-hounds in the Northeast Atlantic. Index ratios based on the mean of the previous two years (Index A: 2019-2020) over the mean of the five preceding years (Index B: 2014 – 2018), depending on the fisheries-independent surveys and data considered. Note: Values as per ICES rounding rules. Option used in the assessment highlighted in bold.

Option	Time-series	Index A	Index B	Ratio A/B
As per advice in 2019 (IBTS-Q1, IBTS-Q3 and EHVOE-WIBTS-Q4)	1997–2020	2.5	1.73	1.43
Combined IBTS (Q1 and Q3) and EHVOE-WIBTS-Q4	1997–2020	2.4	1.88	1.30
Combined IBTS (Q1 and Q3), EHVOE-WIBTS-Q4 and IGFS-WIBTS-Q4	2005–2020	1.82	1.58	1.15
Combined IBTS (Q1 and Q3), EHVOE-WIBTS-Q4, IGFS-WIBTS-Q4 and CGFS-Q4 (incl 2020)	**2005–2020**	**1.76**	**1.42**	**1.24**
Combined IBTS (Q1 and Q3), EHVOE-WIBTS-Q4, IGFS-WIBTS-Q4 and CGFS-Q4 (excl 2020)	2005–2020	1.79	1.42	1.25
Combined IBTS (Q1 and Q3), EHVOE-WIBTS-Q4, IGFS-WIBTS-Q4 and CGFS-Q4 (excl ICES rectangles 29F1 and 30E9)	2005–2020	1.77	1.41	1.25



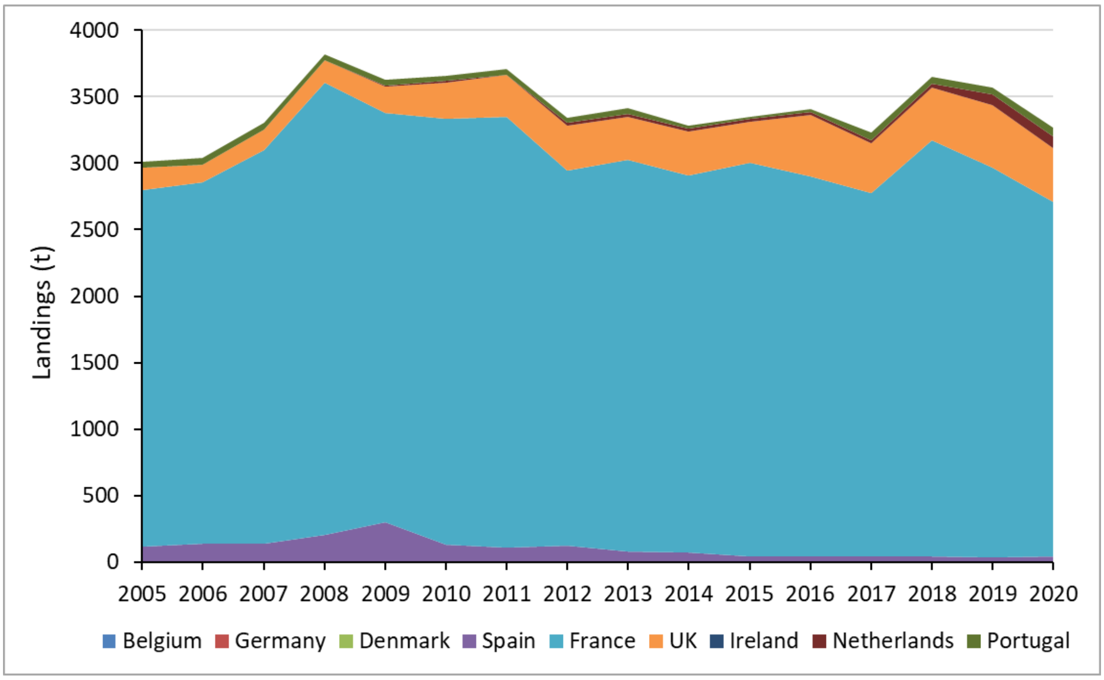


Figure 21.1. Smooth-hounds in the Northeast Atlantic. Earlier ICES estimates of overall *Mustelus* spp. landings by country (2000–2014; top) and revised ICES estimates (2005–2020; bottom). Data are considered underestimates.

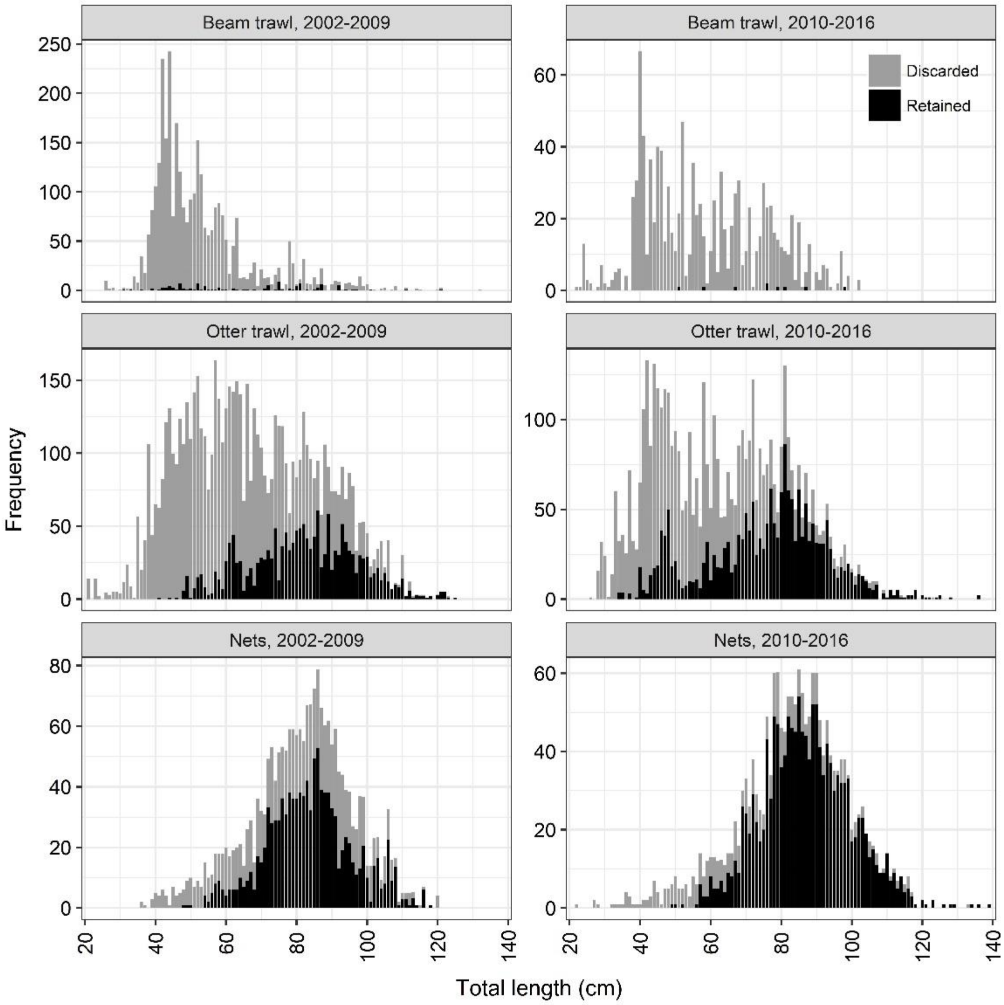


Figure 21.2. Smooth-hounds in the Northeast Atlantic. Length–frequency of discarded (pale grey) and retained (dark grey) starry smooth-hound *Mustelus asterias* caught by beam trawl, otter trawl and gillnets during the periods 2002–2009 and 2010–2016, as recorded in the Cefas observer programme. Data aggregated across North Sea and Celtic Seas ecoregions. (Source: Silva and Ellis, 2019).

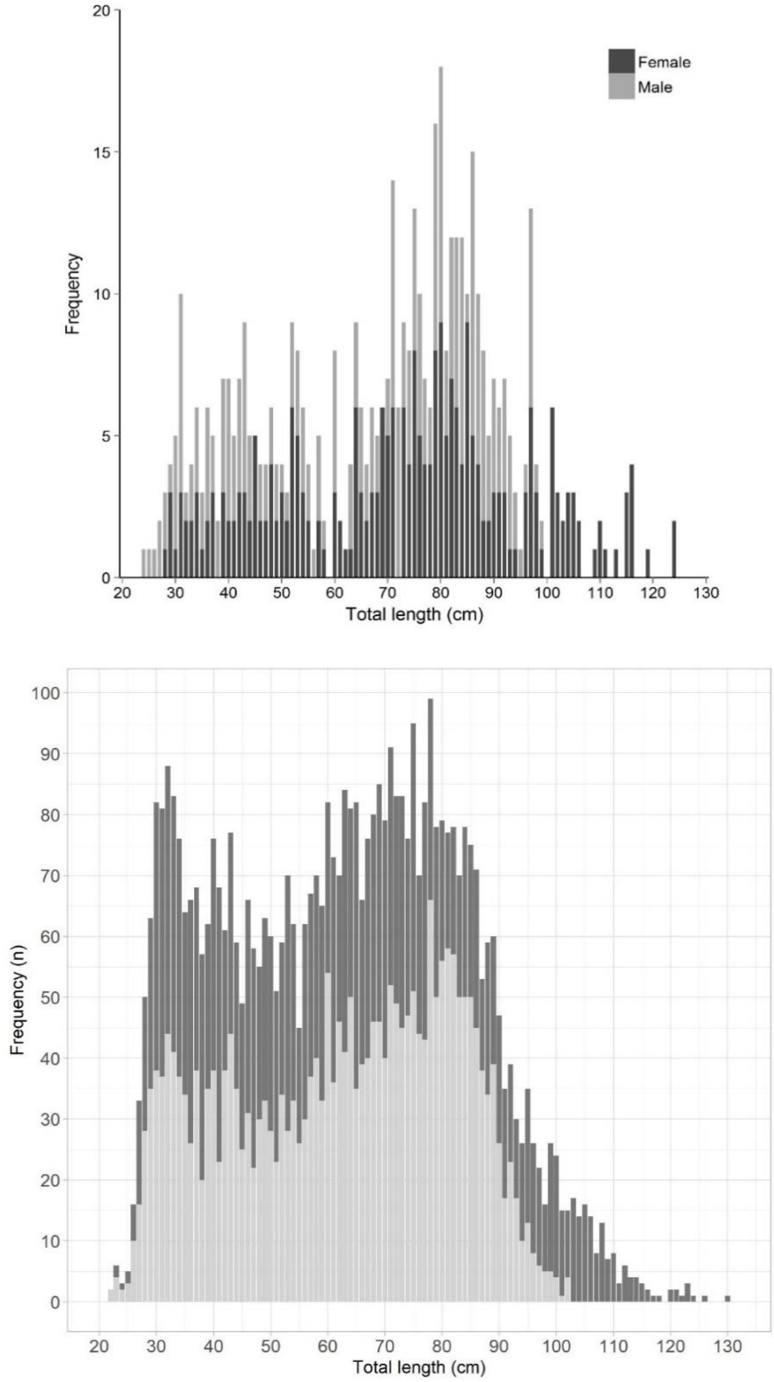


Figure 21.3. Smooth-hounds in the Northeast Atlantic. Number of starry smooth-hounds biologically sampled by length and sex (top) n = 504 from McCully Phillips and Ellis (2015) and (bottom) n = 4951 from Ellis *et al.* (2019 WD).

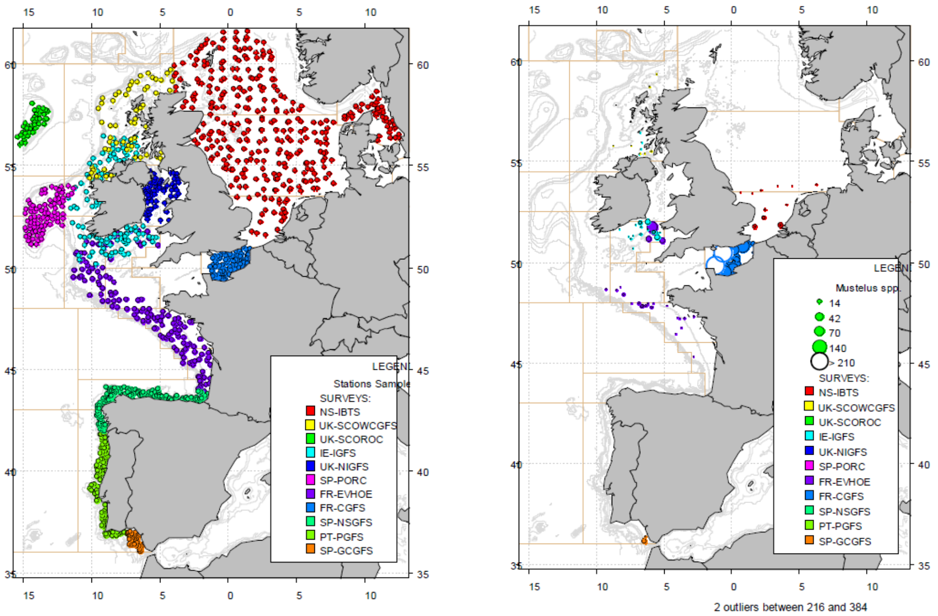


Figure 21.4. Smooth-hounds in the Northeast Atlantic. IBTS hauls undertaken in Q3 and Q4 2015 (left) and corresponding catches of *Mustelus* spp. (right). The catchability of the different gears used in the NE Atlantic surveys is not constant; therefore, the map does not reflect proportional abundance in all the areas but within each survey. Source: ICES (2016b).

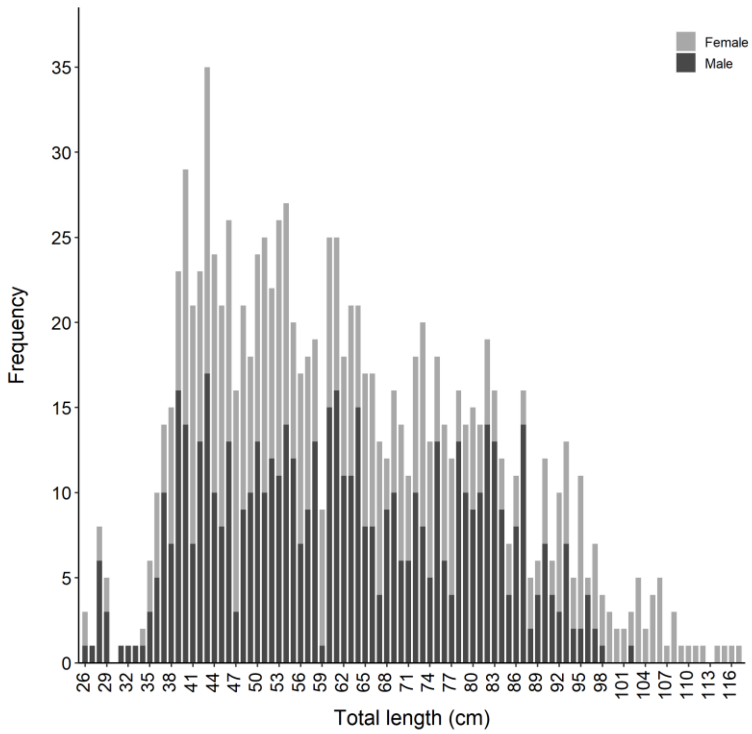


Figure 21.5. Smooth-hounds in the Northeast Atlantic. Length–frequency by sex of smooth-hounds *Mustelus* spp. encountered during the UK Western Channel Q1 Beam-trawl survey 2006–2019 (incorporating the Celtic Sea 2014–2019). Source: Silva *et al*. (2020 WD).

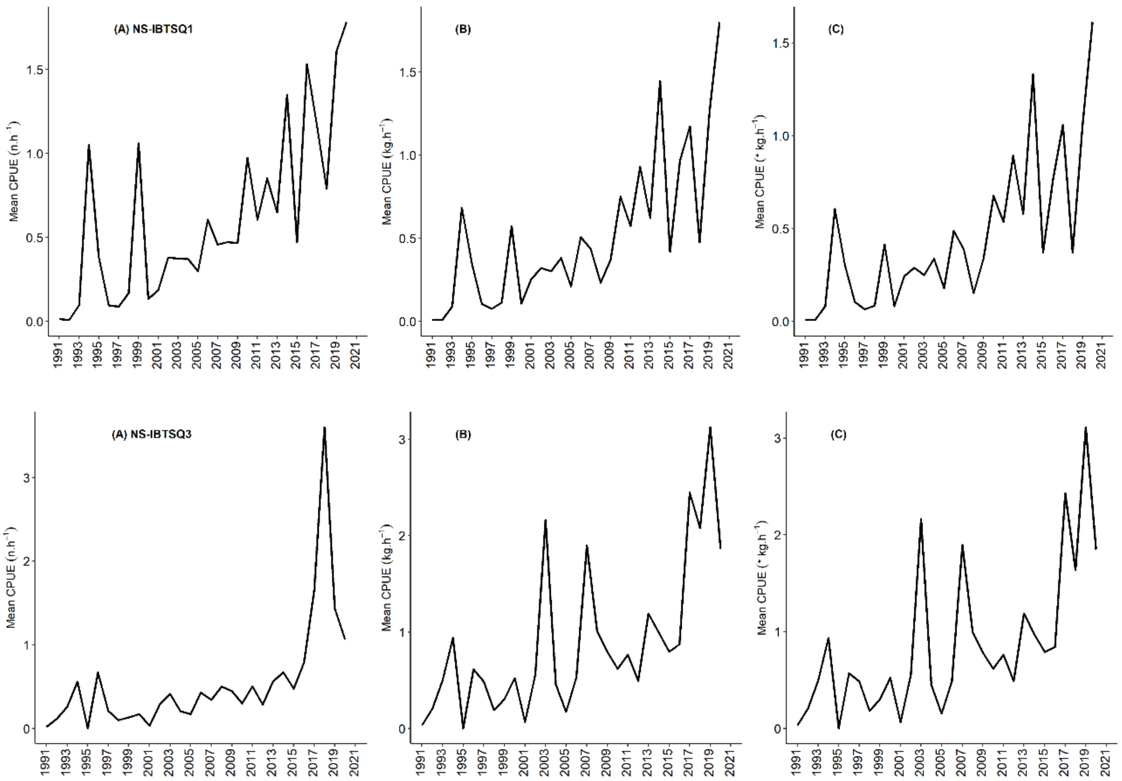


Figure 21.6. Smooth-hounds in the Northeast Atlantic. Survey indices (A - number per hour; B - estimated biomass per hour; and C - estimated exploitable biomass for individuals ≥50 cm total length) in IBTS-Q1 (top) and IBTS-Q3 (bottom) of the North Sea. Note: IBTS-Q3 excludes data for RV *Dana*. Updated survey index in 2021 for whole time series.

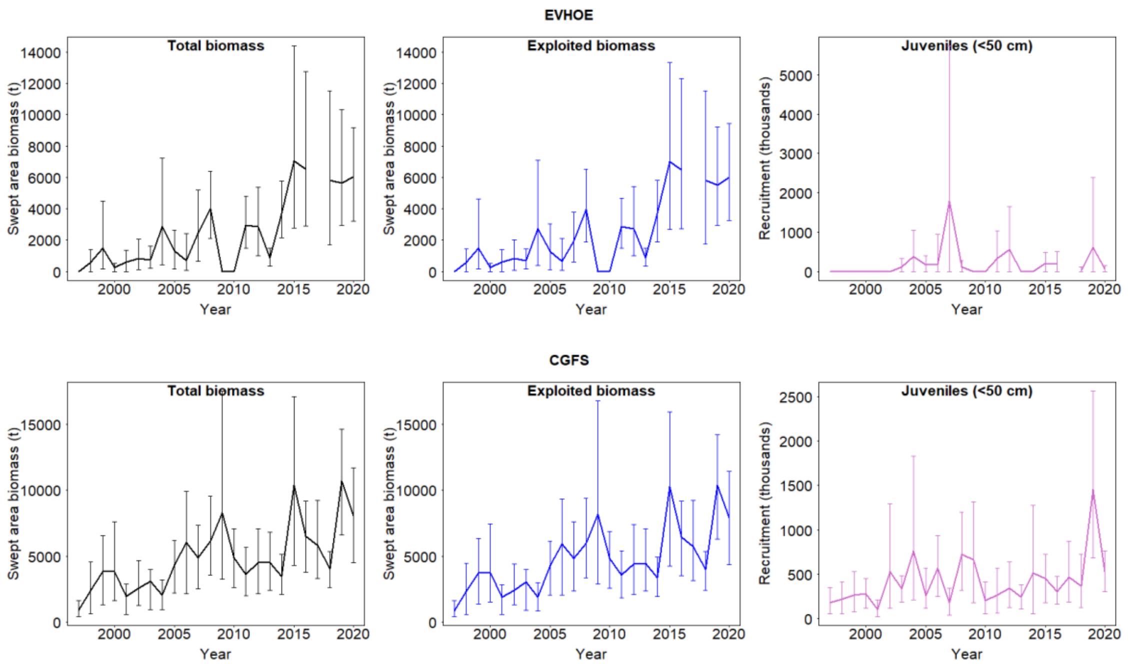


Figure 21.7. Smooth-hounds in the Northeast Atlantic. Swept area exploitable biomass index with 95% confidence intervals from the EVHOE-WIBTS-Q4 survey in divisions 7.g-j, 8.a.b.d (top) and CGFS-Q4 in Division 7.d (bottom). Note: EVHOE-WIBTS-Q4 indices updated in 2021 for whole time series, survey did not occur in 2017. Source: DATRAS.

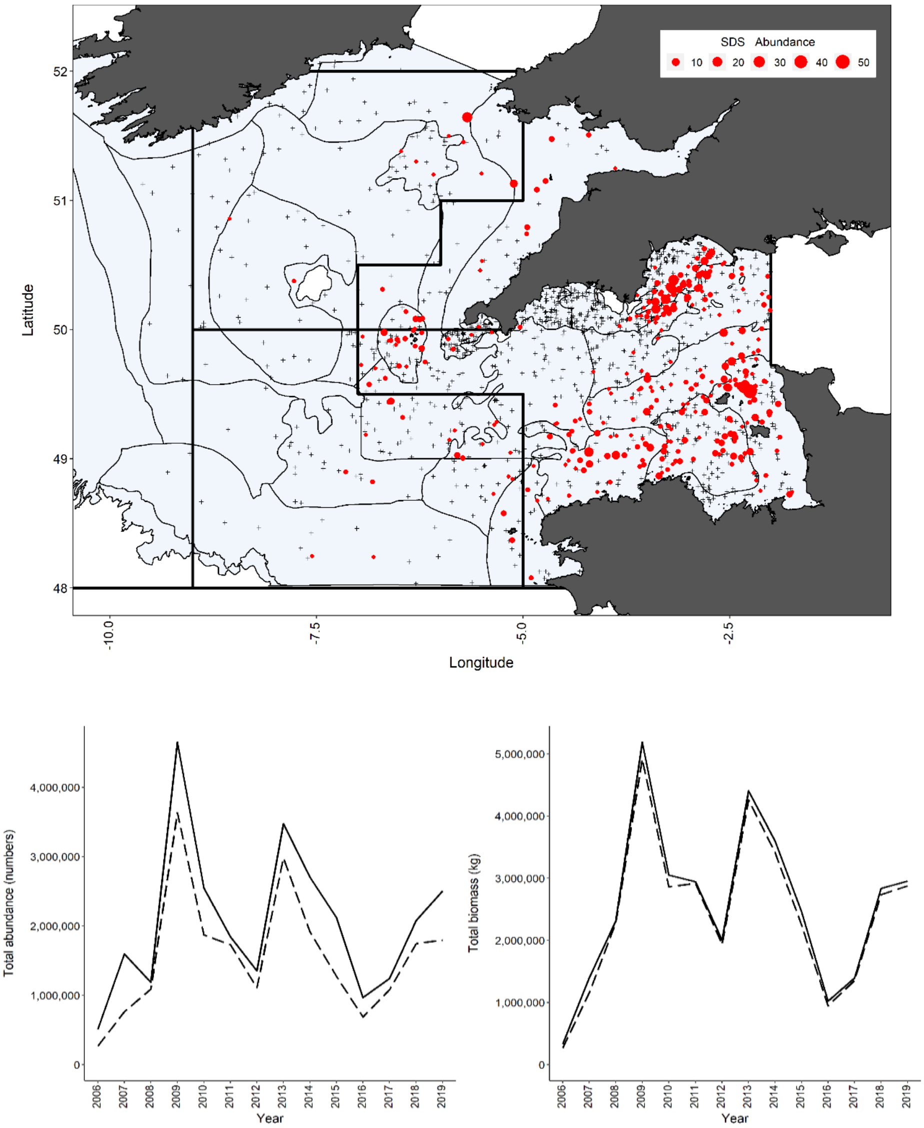


Figure 21.8. Smooth-hounds in the Northeast Atlantic. Survey grid of the UK-Q1SWBEAM survey (2006–2019) indicating the distribution and relative abundance of *Mustelus* spp. (top), and the total abundance (numbers in 7.e) and total biomass (kg in 7.e) for *Mustelus* spp (bottom). Continuous line relates to all specimens, dashed line relates to individuals ≥50 cm total length. Source: Silva *et al*. (2020 WD).

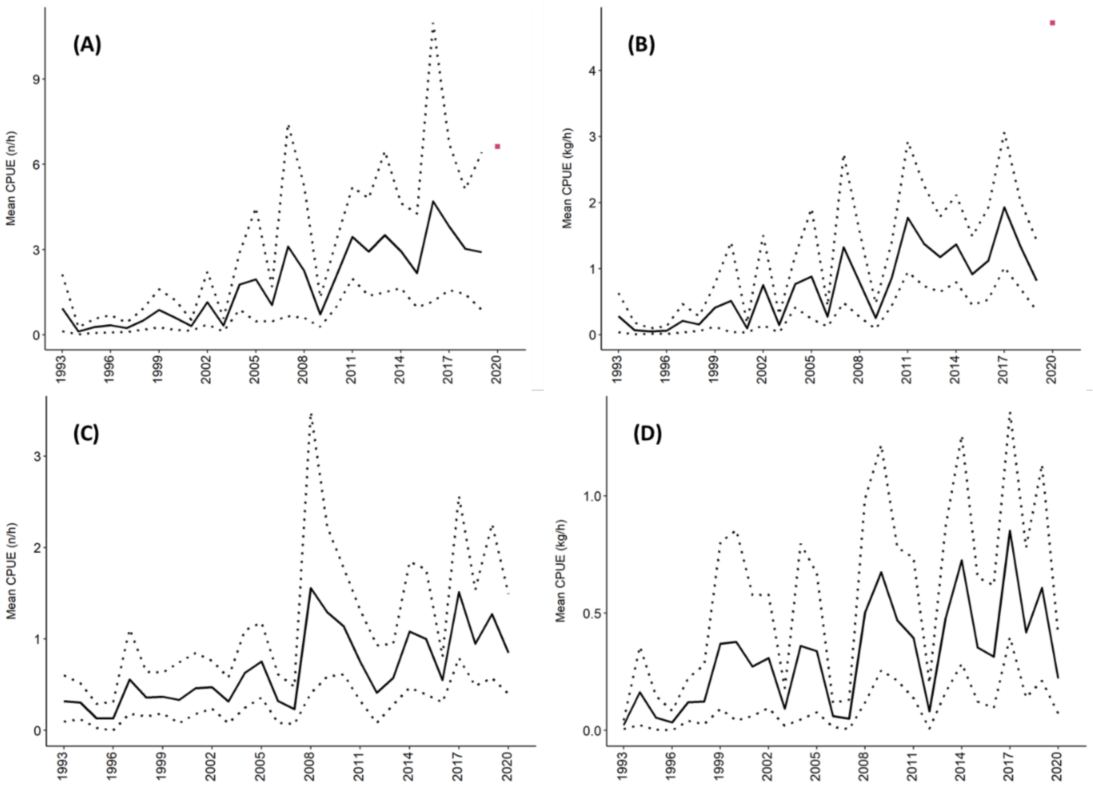


Figure 21.9. Smooth-hounds in the Northeast Atlantic. Survey indices and associated confidence intervals (number per hour for all individuals, estimated total biomass per hour and 95%CI) from BTS-UK (E&W)-Q3 in the Bristol Channel and Irish Sea (top, panel A and B) and BTS-Eng-Q3 in the eastern English Channel and southern North Sea (bottom, panel C and D). Note: 2020 value (top, panel A and B) shown as pink square without 95%CI should be viewed with caution (see Section 21.6.2). Updated survey indices in 2021 for whole time series.

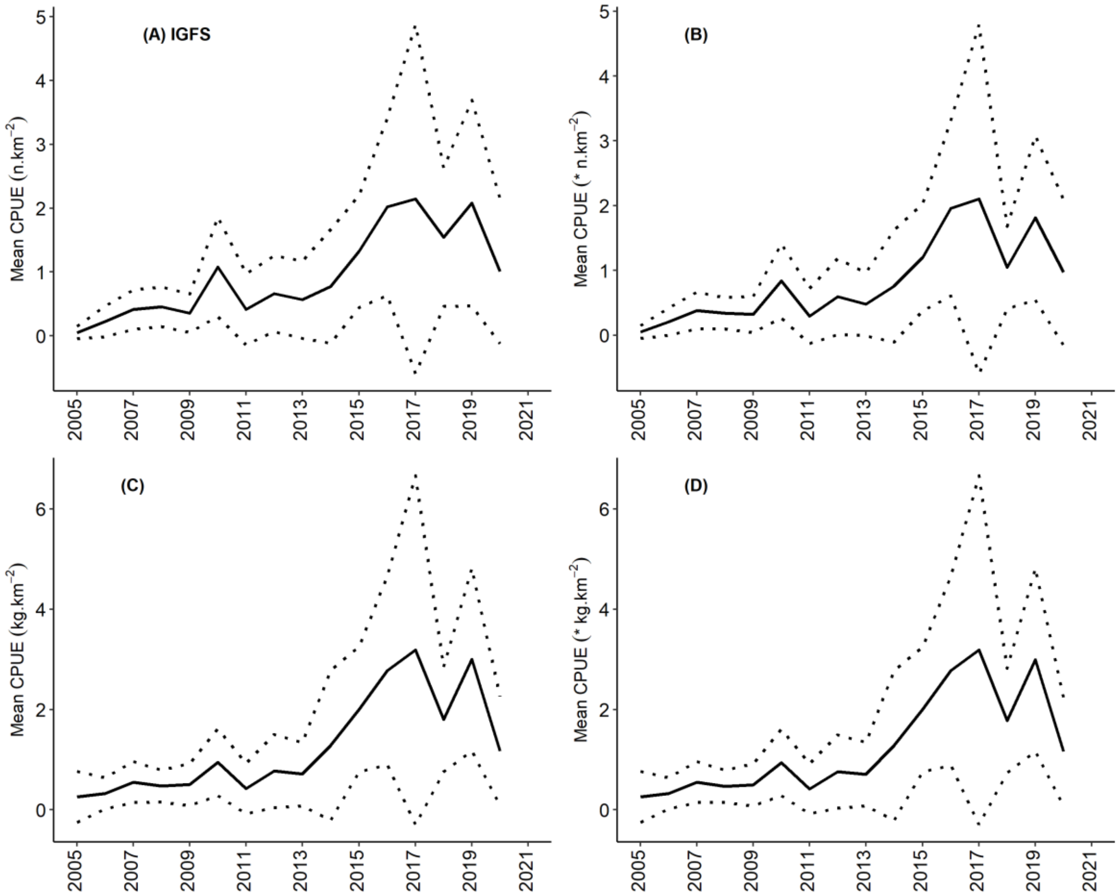


Figure 21.10. Smooth-hounds in the Northeast Atlantic. Survey indices and associated confidence intervals (95%CI) by (A) total abundance (n.km^{-2}), (B) total biomass (kg.km^{-2}), (C) abundance for individuals ≥50 cm total length (*n.km^{-2}) and (D) biomass for individuals ≥50 cm total length (*kg.km^{-2}) from the IGFS-WIBTS-Q4.

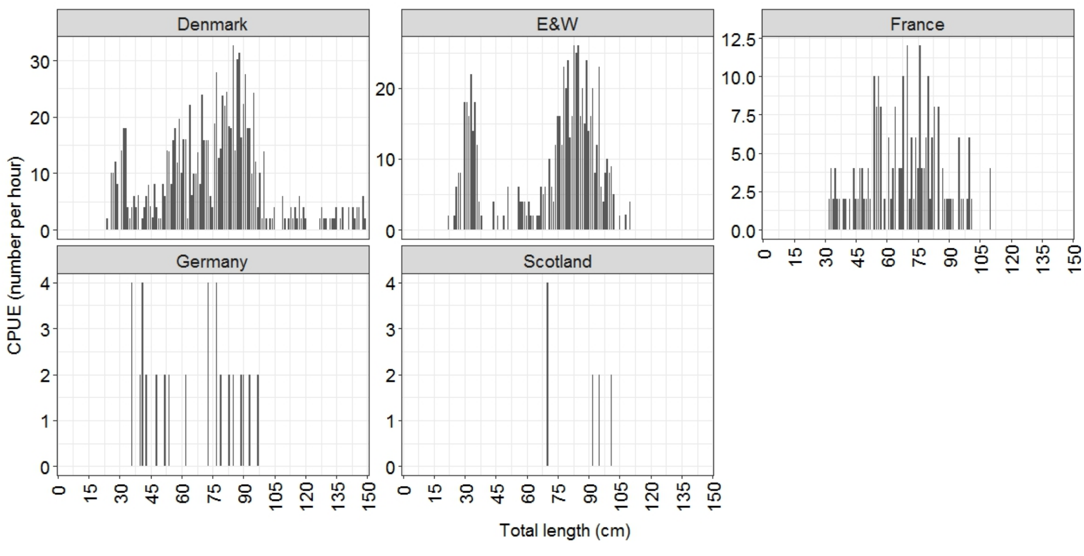


Figure 21.11. Smooth-hounds in the Northeast Atlantic. Length distributions of *Mustelus* spp. in the Q3-IBTS of the North Sea by nation during 1992–2016. Most nations record *Mustelus* spp. up to 110 cm, while Danish data (to 149 cm) suggests there may be misidentification with *Galeorhinus galeus* or coding errors.

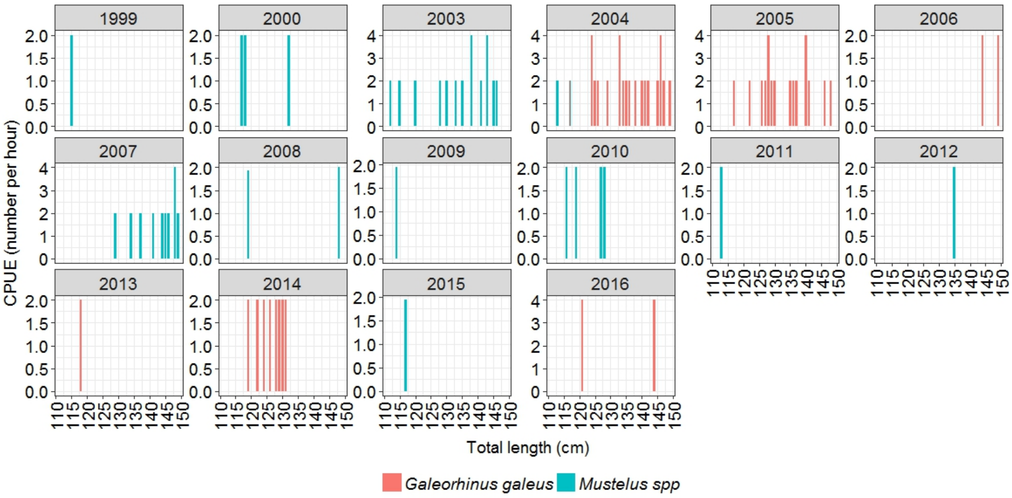


Figure 21.12. Smooth-hounds in the Northeast Atlantic. Length distributions of triakid sharks ≥110 cm as reported on DATRAS during IBTS-Q3 for the RV *Dana* (1992–2016). Large specimens of triakid sharks (i.e. *Mustelus* spp. or *Galeorhinus galeus*) are not usually captured in the same year, which suggests potential identification issues or coding errors.

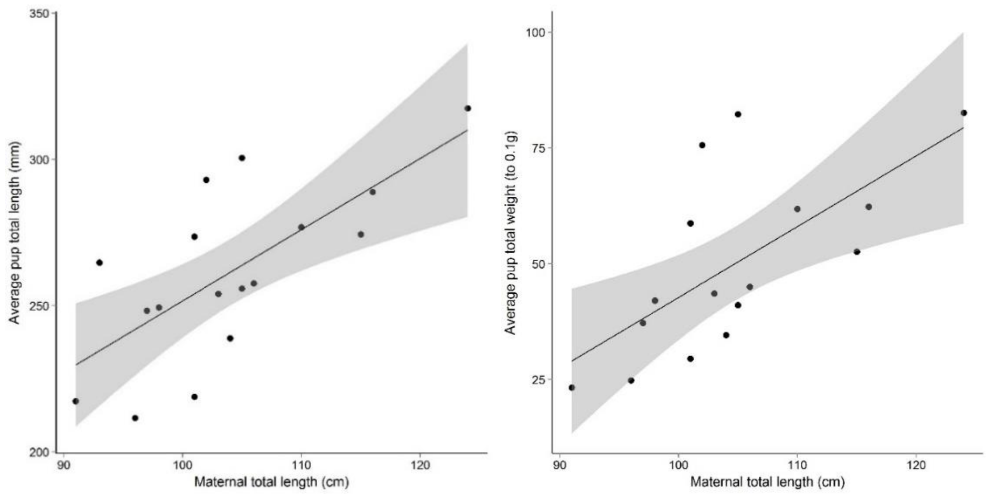


Figure 21.13. Smooth-hounds in the Northeast Atlantic. Relationship between maternal total length and average length and weight of term pups. Source: McCully Phillips and Ellis (2015).

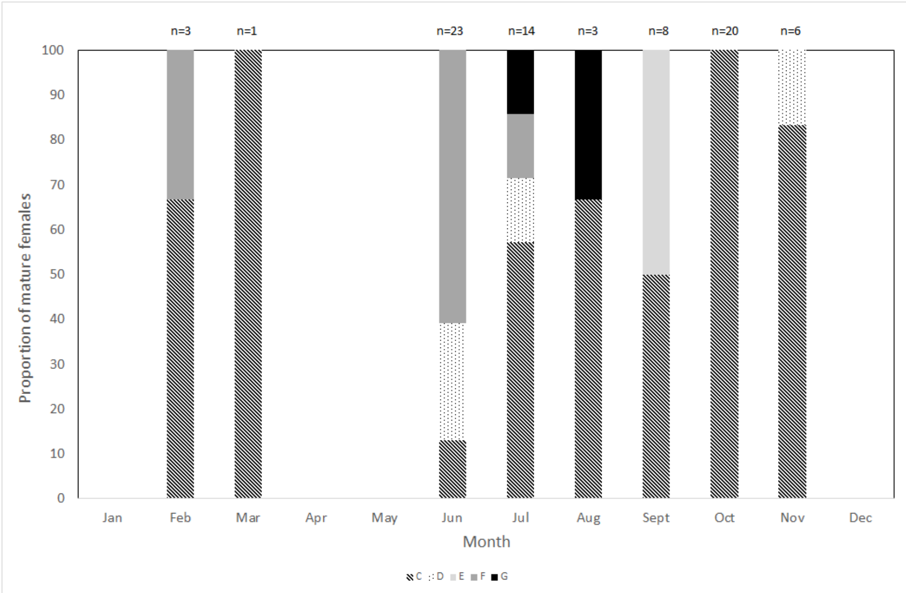


Figure 21.14. Smooth-hounds in the Northeast Atlantic. Percentage of mature females at each developmental stage (D: early gravid; E: mid-gravid; F: late gravid; G: post-partum) by month. Source: McCully Phillips and Ellis (2015).

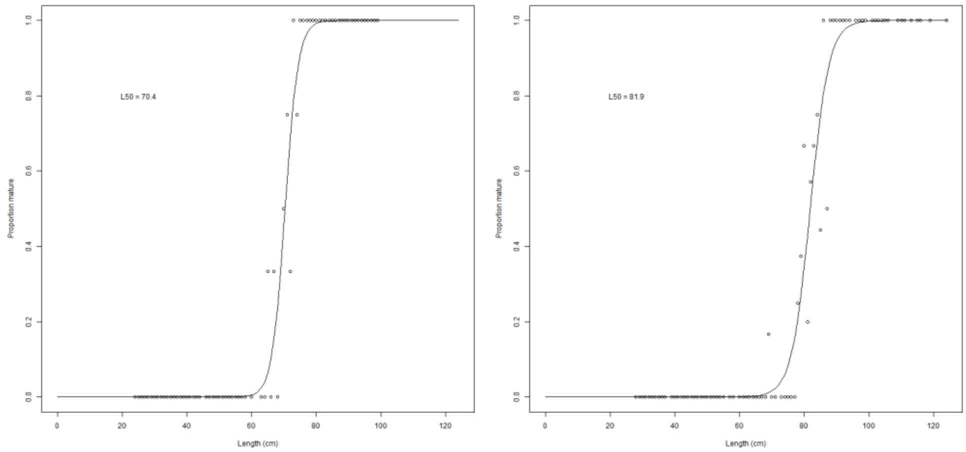


Figure 21.15. Smooth-hounds in the Northeast Atlantic. Maturity ogive for male (n = 237; L_{50} = 70.4 = cm L_T) and female (n = 248; L_{50} = 81.9 cm L_T) *M. asterias*. Source: McCully Phillips and Ellis (2015).

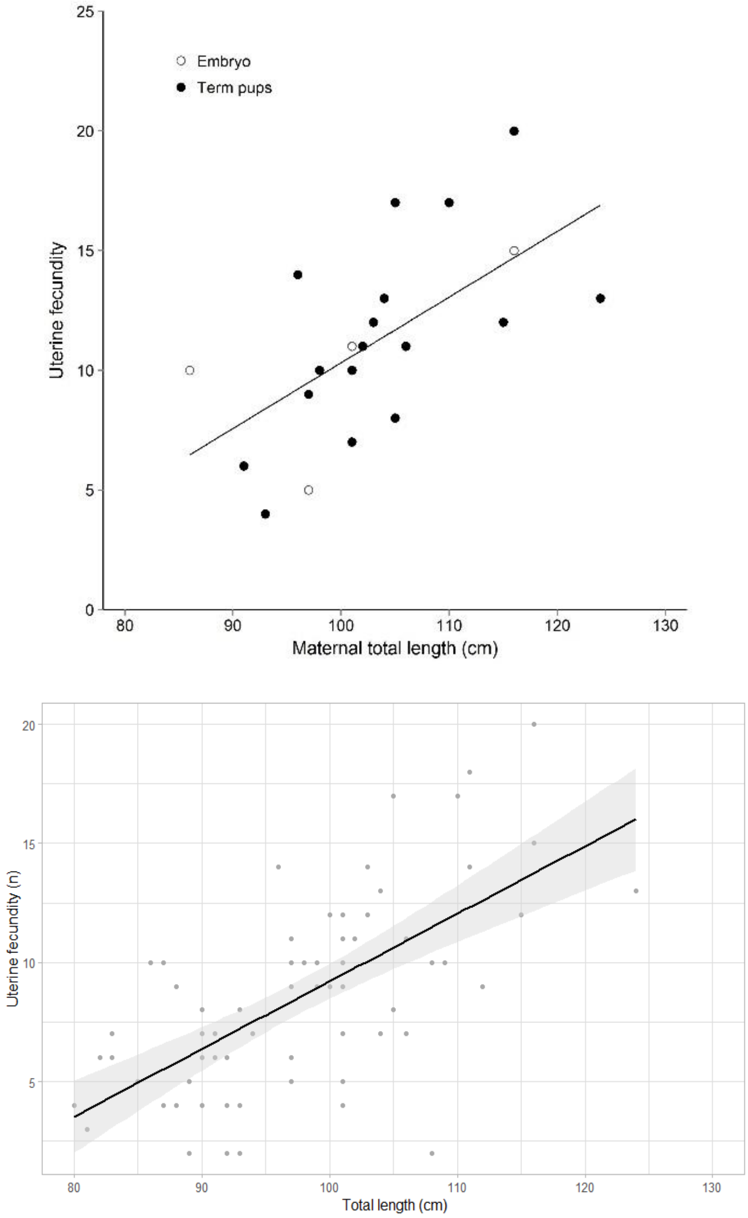


Figure 21.16. Smooth-hounds in the Northeast Atlantic. Relationship between maternal total length and uterine fecundity (top) from McCully Phillips and Ellis (2015) and (bottom) from Ellis *et al.* (2019 WD).

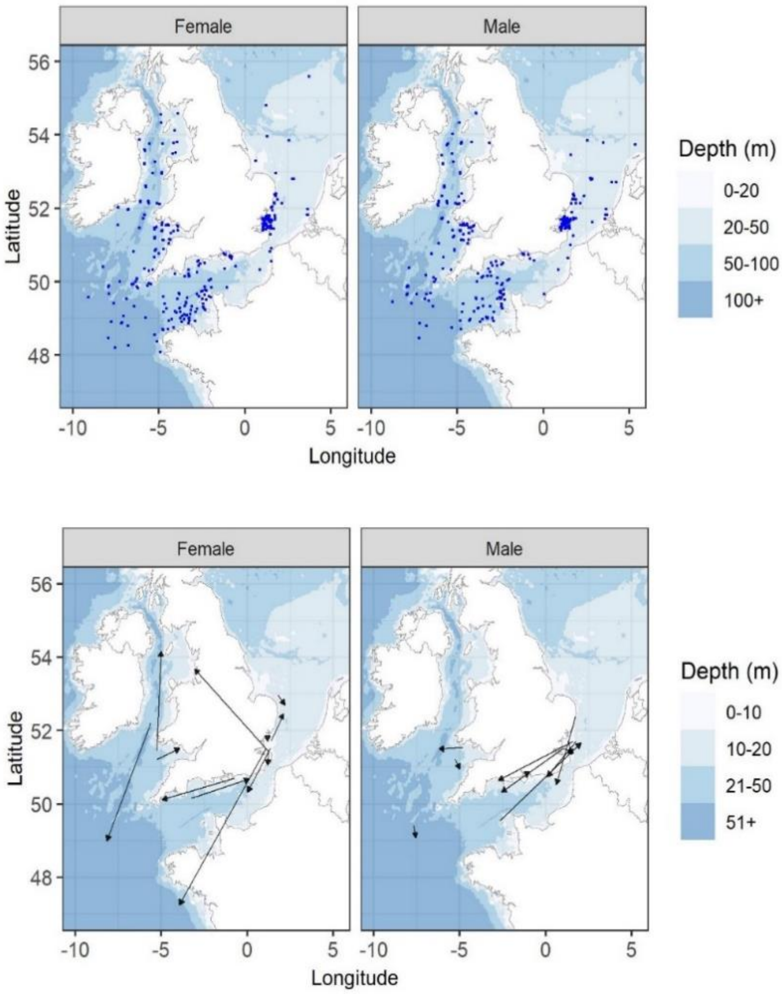


Figure 21.17. Smooth-hounds in the Northeast Atlantic. Tagging locations (top) and displacement vectors (bottom) for male and female *M. asterias*. Source: Ellis *et al.* (2019 WD).

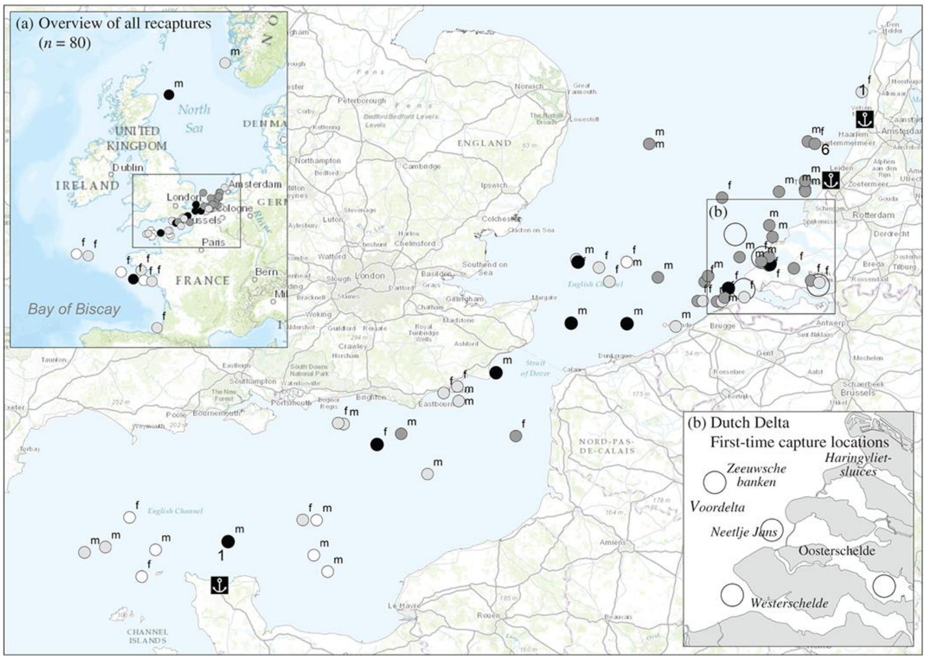


Figure 21.18. Smooth-hounds in the Northeast Atlantic. The main map shows the more detailed distribution of recaptures in the English Channel and southern North Sea. From three fish markets (indicated with anchors), eight tagged *M. asterias* were reported (numbers next to the anchors represent the number of sharks from each fish market) with unknown recapture location. Inset (a) shows the locations of recaptured *Mustelus asterias* (n = 80) reported by quarter for the years 2011–2014. Their distribution pattern indicates a circannual migration between the Dutch Delta (summer), the English Channel and Bay of Biscay (winter). Inset (b) shows the tag and release location with the main places fished indicated with open circles. Symbols: f = female; m = male; recaptures per quarter are shown for January to March (○), April to June (○), July to September (●) and October to December (●). Source: Brevé *et al*. (2016).

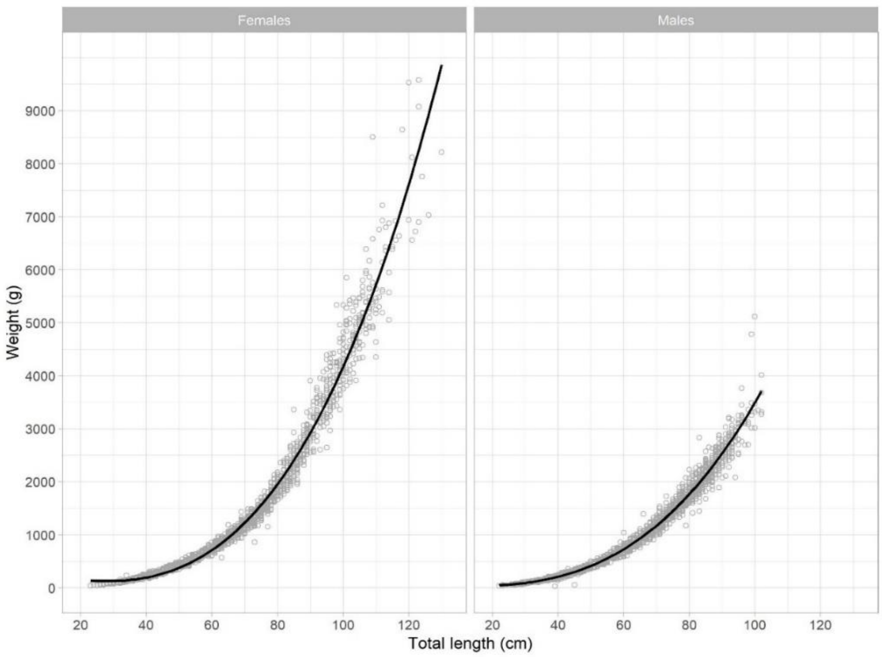


Figure 21.19. Smooth-hounds in the Northeast Atlantic. Length–weight relationships for female and male *M. asterias* caught in fishery-independent trawl surveys conducted by Cefas between 2009–2019. Relationships are described by the equations: females, $M_T = 0.002\ T_L^{3.1}$ ($r^2 = 0.992$, n = 2323); males, $M_T = 0.003\ T_L^{3.0}$ ($r^2 = 0.991$, n = 2471). M_T = Total weight (g), L_T = Total length (cm). Source: Ellis *et al*. (2019 WD).

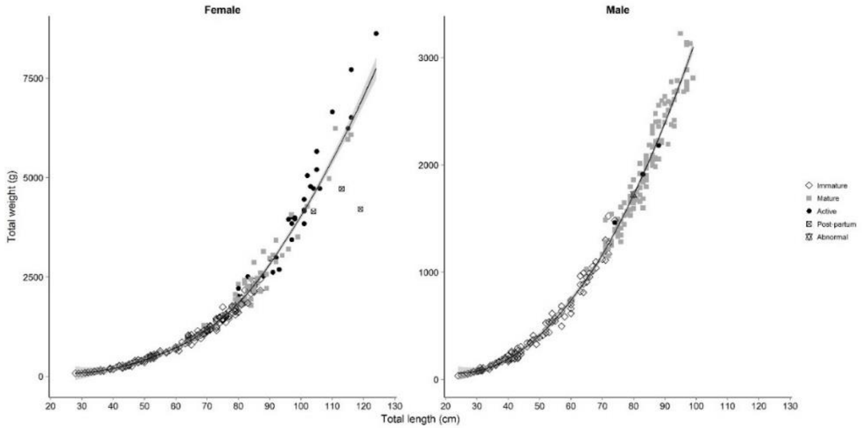


Figure 21.20. Smooth-hounds in the Northeast Atlantic. Length–weight relationship for female (n = 248) and male (n = 237) *M. asterias* by maturity stage (shaded region showing 95% confidence intervals). Source: McCully Phillips and Ellis (2015).

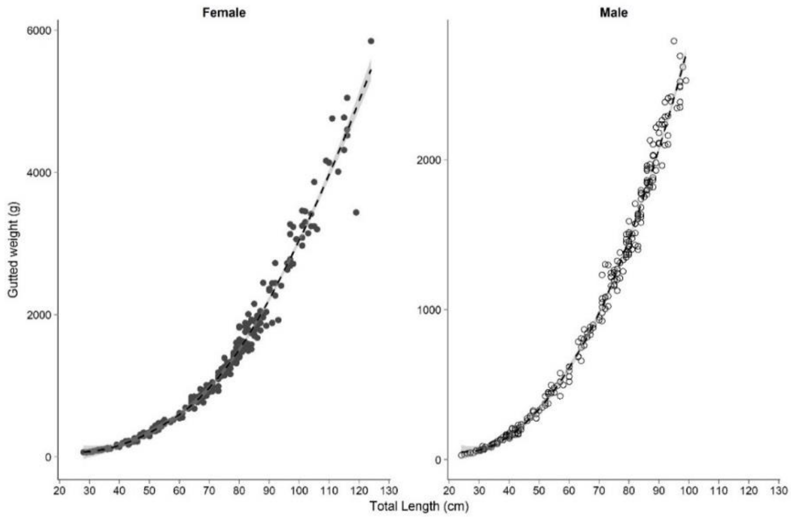


Figure 21.21. Smooth-hounds in the Northeast Atlantic. Total length to gutted weight relationship for female (n = 249) and male (n = 235) *M. asterias* (shaded region showing 95% confidence intervals). Source: McCully Phillips and Ellis (2015).

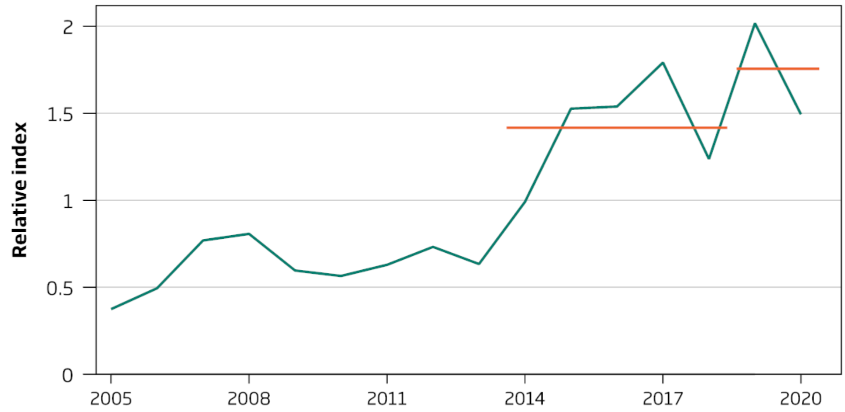


Figure 21.22. Smooth-hounds in the Northeast Atlantic. Stock size indicator is the mean normalized exploitable biomass index (individuals of ≥ 50 cm total length) of starry smooth-hound from the average of the two NS-IBTS surveys (NS–IBTS–Q1 and NS–IBTS–Q3), EVHOE–WIBTS–Q4, CGFS–Q4 and IGFS–WIBTS–Q4. The horizontal lines show the average of the most recent two-years (2019–2020) and the preceding five-years (2014–2018).

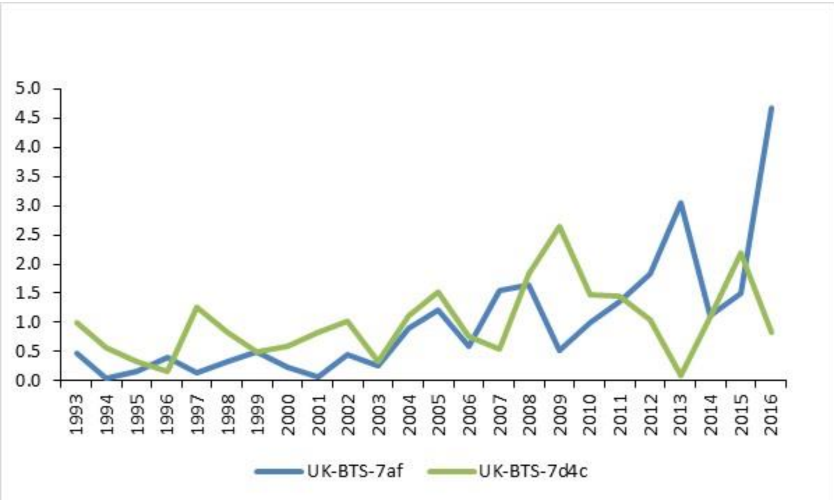


Figure 21.23. Smooth-hounds in the Northeast Atlantic. Annual catch rate of pups (<35 cm) in the BTS-UK (E&W)-Q3 (Bristol Channel and Irish Sea) and BTS-Eng-Q3 (eastern English Channel and southern North Sea) for the years 1993–2016, each standardised to the long-term mean for the survey.

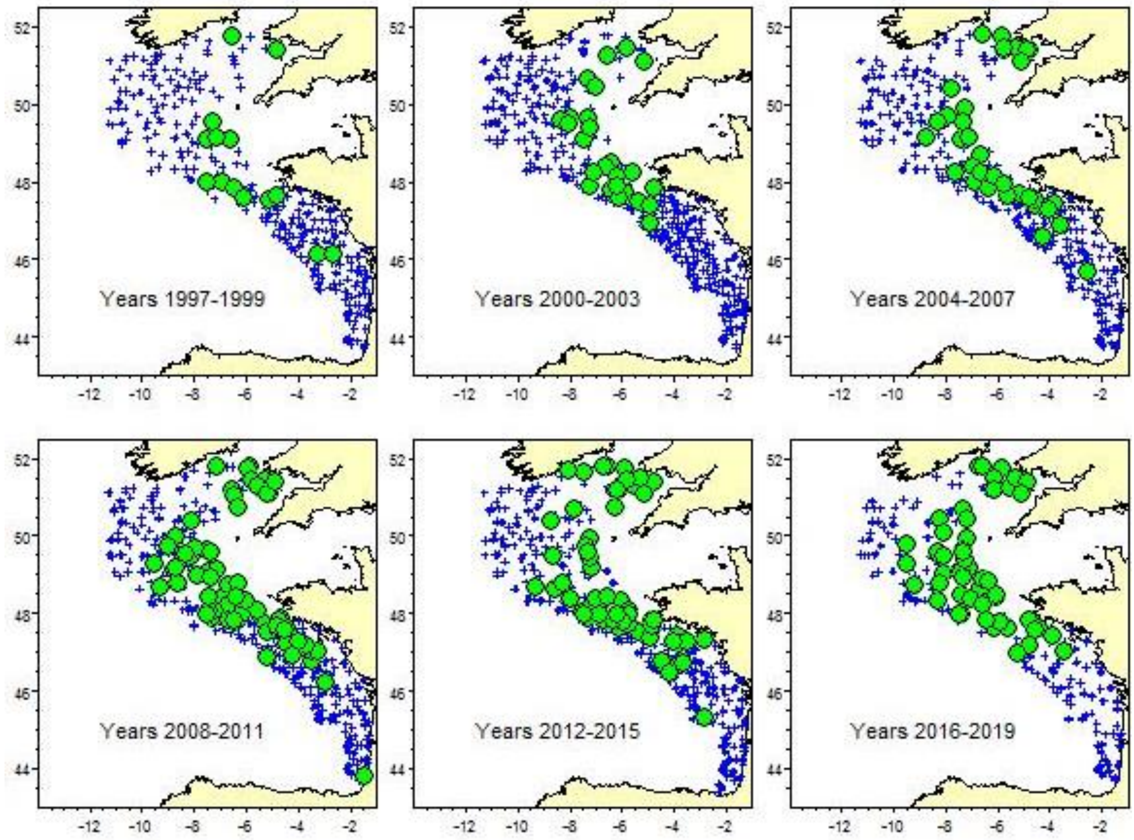
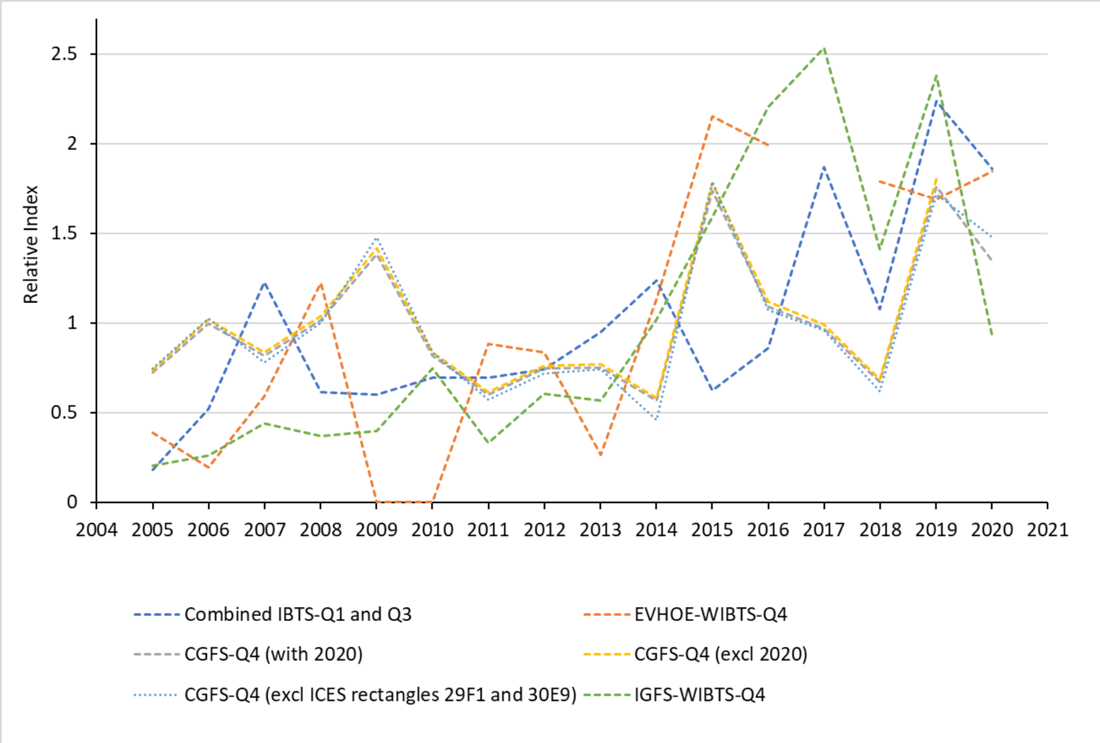


Figure 21.24. Smooth-hounds in the Northeast Atlantic. Distribution of occurrences of *Mustelus* spp. (green points) in the EVHOE-WIBTS-Q4 survey (1997–2019) by groups of 4 years. Source: National data (Ifremer) .



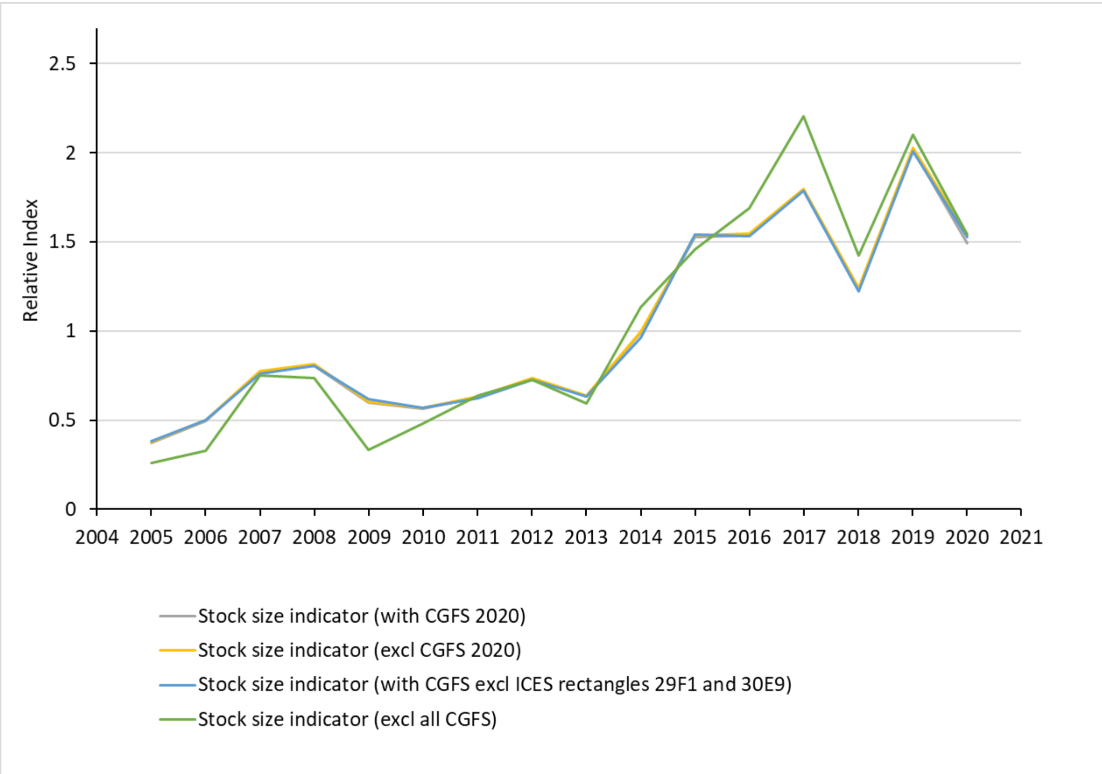


Figure 21.25. Smooth-hounds in the Northeast Atlantic. Normalized survey indices for starry smooth-hound (individuals ≥50 cm total length) for combined IBTS-Q1 and Q3, EVHOE-WIBTS-Q4, CGFS-Q4 (with 2020), CGFS-Q4 (excl 2020), CGFS-Q4 (excl ICES rectangles 29F1 and 30E9) and IGFS-WIBTS-Q4 (top), and different scenarios for stock size indicators for 2005–2020 (bottom).

22 Angel shark *Squatina squatina* in the Northeast Atlantic

22.1 Stock distribution

Angel shark *Squatina squatina* was historically distributed from the British Isles southwards to western Africa, including the Mediterranean Sea (Roux, 1986). As such the species distribution covers parts of ICES subareas 4 and 6–9.

Stock structure is not known, but available data for this and other species of angel shark indicate high site specificity and possibly localized stocks. Mark–recapture data for angel shark have shown that a high proportion of fish are recaptured close to the original release location (Quigley, 2006), although some individuals undertake longer-distance movements. The failure of former populations in the southern North Sea and parts of the English Channel to re-establish is also suggestive of limited mixing. Studies on other species of angel shark elsewhere in the world have also indicated that angel sharks show limited movements and limited mixing (e.g. Gaida, 1997; Garcia *et al.*, 2015). STECF (2003) noted that angel sharks "*should be managed on smallest possible spatial scale*". The long-term decline of this species from various parts of its geographic range have been reported in recent studies (e.g. Hiddink *et al.,* 2019; Shepherd *et al.,* 2019; Bom *et al.,* 2020).

Given that this species is considered to be extirpated from parts of its North Atlantic range and is highly threatened both in the ICES area and elsewhere in its geographical range, ICES provide advice at the species level.

22.2 The fishery

22.2.1 History of the fishery

Angel shark is thought to have been the subject of exploitation for much of the 19th century and parts of the 20th century, and was exploited for meat, liver and skin. This species was the original fish termed 'monkfish' until catches declined and anglerfish *Lophius piscatorius* became a marketable species. As catches declined over the course of the 20th century, it was landed occasionally as a 'curio' for fish stalls.

Given the coastal nature of the species, it was also subject to fishing pressure from recreational fishing in parts of its range (e.g. the coasts of Ireland and Wales).

The species has been extirpated from parts of its former range, and most reports of this species in the ICES area are now from occasional bycatch records in trawl and gillnet fisheries (e.g. Tully, 2011; Iglésias *et al.*, 2020).

22.2.2 The fishery in 2020

No new information.

22.2.3 ICES Advice applicable

In 2008, ICES advised that angel shark in the North Sea eco-region was "*extirpated in the North Sea. It may still occur in Division VIId*" (ICES, 2008a). For the Celtic Seas, ICES advised that it "*has a localized and patchy distribution, and is extirpated from parts of its former range. It should receive the highest possible protection. Any incidental bycatch should not be landed, but returned to the sea, as they are likely to have a high survival rate*" (ICES, 2008b).

In both 2010 and 2012, ICES advised that it should remain on the list of Prohibited Species (ICES, 2012).

In 2015, ICES advised that "*when the precautionary approach is applied for angel shark in the Northeast Atlantic, no targeted fisheries should be permitted and bycatch should be minimized. ICES considers that this species should remain on the EU prohibited species list. This advice is valid for 2016 to 2019*".

In 2019, ICES advised that "*when the precautionary approach is applied, there should be zero catches in each of the years 2020–2023*".

22.2.4 Management applicable

Council Regulation (EC) 43/2009 stated that "*Angel shark in all EC waters may not be retained on board. Catches of these species shall be promptly released unharmed to the extent practicable*".

It was subsequently included on the list of Prohibited Species, under which it is prohibited for EU vessels to fish for, to retain on board, to transship and to land angel shark in EU waters (e.g. Council Regulations (EC) 2018/120).

In 2019, angel shark was listed as a prohibited species (in all Union waters) on Annex I of EU (2019), and thus is no longer specified on the annual documents relating to EU fishing opportunities.

Within the Mediterranean Sea, GFCM "*Recommendation GFCM/42/2018/2 on fisheries management measures for the conservation of sharks and rays in the GFCM area of application, amending Recommendation GFCM/36/2012/3*" states that "*CPCs shall ensure a high protection from fishing activities for elasmobranch species listed in Annex II of the SPA/BD Protocol of the Barcelona Convention* [that includes angel shark], *which must be released unharmed and alive, to the extent possible*" and that "*Specimens of shark species listed in Annex II of the SPA/BD Protocol shall not be retained on board, transhipped, landed, transferred, stored, sold or displayed or offered for sale*".

Within the UK, angel shark is afforded protection through its listing on the Wildlife and Countryside Act (WCA) and it is also listed on Scottish Statutory Instrument (SI) 2012 No. 63 (the Sharks, Skates and Rays (Prohibition of Fishing, Trans-shipment and Landing) (Scotland) Order).

In 2017, angel shark was added to Appendices I and II of the Convention on the Conservation of Migratory Species of Wild Animals (CMS; see Section 22.12). CMS Parties that are Range States to Appendix I listed species should, under Article III(5), "*prohibit the taking of animals belonging to such species*".

In 2019, The Spanish Ministerio para la Transición Ecológica updated the national "*Listado de Especies Silvestres en Régimen de Protección Especial y del Catálogo Español de Especies Amenazadas*" (List of Wild Species under Special Protection Regime and the Spanish Catalogue of Threatened Species) to include angel shark (Boletín Oficial del Estado, BOE, 2019).

22.3 Catch data

22.3.1 Landings

Angel shark became increasingly rare in landings data over the available time period and was reported only rarely prior to it being listed as a Prohibited Species (Table 22.1; Figure 22.1). It is believed that the peak in UK official landings in 1997 from Divisions 7.j-k were either misreported anglerfish (also called monkfish) or hake, given that angel shark is a more coastal species. These figures have been removed from the WGEF estimates of landings. French landings declined from >20 t in 1978 to less than 1 t per year prior to the prohibition on landings.

Whilst some nominal records were available in French national landings data for 2012 and 2013, the reliability of these data is uncertain, due to the areas and quantities reported, and catch gears. Further analyses and clarification of these data are required, and as such they are not included here.

There are no data available for the numbers of angel shark landed during the recreational fisheries that existed in parts of their range.

22.3.2 Discards

Limited data are available. Analyses of the main discard observer programme for the English and Welsh fleets found that no angel sharks had been observed (Silva *et al.*, 2019), whilst observer trips conducted by the Sea Mammal Research Unit (SMRU) recorded three individuals over the period 2011–2014 (Allen Kingston, pers. comm. 2015). These specimens were caught on 29 April 2011 (50.93°N, 6.65°W, 95 m water depth) and 19 September 2014 (53.40°N, 3.60°W and 53.40°N, 3.63°W, 15–16 m water depth). All were caught in tangle or trammel nets (soak times of 64–78 hours), were of estimated individual weights of 15–25 kg and were all dead.

Examination of data collected under the French discard observer programme (2003–2013) indicated that only two individuals were observed (both in 2012) in the ICES area. According to observations from French fish markets and catches reported by fishermen, four additional individuals (two in 2007 and two in 2010) were also caught (S. Iglésias, pers. comm.). All these six individuals were caught off Pembrokeshire (Wales) at the southern entrance to St George's Channel. Iglésias *et al.* (2020) reported that a female angel shark (126 cm; 26 kg) caught by a bottom trawler (51.3810-51.4823°N; 5.5248–5.5603°W; 100 m depth; March 2018) was not discarded but eaten on board. It is unknown if this was an isolated incidence.

WKSHARK3 also reviewed available information on angel sharks observed during on-board observer programmes, also concluding this species was only observed very occasionally (ICES, 2017).

Further collation and analyses of contemporary discard and observer data should be undertaken at the 2023 WGEF meeting.

22.3.3 Quality of catch data

Catch data are incomplete, as data are unavailable for the periods when angel shark was more abundant. There are some concerns over the quality of some of the landings data (see above). The listing as a 'Prohibited Species' will result in commercial landings data nearing zero. Further studies of possible bycatch and fate of discards in known areas of occurrence would be needed to better estimate commercial catch.

Following the WKSHARKS data call in 2016, landings data-from 2005–2015 were re-assessed by WGEF. There were no major differences between previous landings and the new figures.

22.3.4 Discard survival

Limited data exist for the discard survival of angel shark caught in European fisheries. All three specimens observed by SMRU observers after capture by tangle- or trammel net were dead; soak times were 64–78 hours. Recently published observations from Corsica (Mediterranean) indicated that angel sharks caught by trammel nets in shallow water (<5 m depth) with shorter (<12 h) soak times could be released alive (Lapinski & Giovos, 2019).

Other angel shark species have been studied elsewhere in the world (Ellis *et al.*, 2017). Fennessy (1994) reported at-vessel mortality (AVM) of 60% for African angel shark *Squatina africana* caught by South African prawn trawlers. Braccini *et al.* (2012) reported AVM of 25% for Australian angel shark *S. australis* caught by gillnet (where soak times were <24 h).

22.4 Commercial catch composition

No data available.

22.5 Commercial catch and effort data

No data available for commercial fleets.

22.5.1 Recreational catch and effort data

Information from Inland Fisheries Ireland (IFI) was used by WGEF 2015 to inform on the status of angel shark. This exercise suggested that the number of specimen individuals caught by recreational fishers and reported to the specimen fish committee declined over the period 1958–2005 (Table 22.2), with an overall decline in the numbers caught (Figure 22.2).

Other data from the IFI National Marine Sport Fish Tagging Programme confirm the scarcity of angel shark. Tagging of angel sharks has declined markedly in the last 25 years. A total of 1029 individuals have been tagged since 1970, but only a single individual has been tagged since 2006, and no recaptured specimens reported since 2004 (Roche and O'Reilly, 2013 WD; Wögerbauer *et al.*, 2014 WD). Angel shark is now only caught by anglers very occasionally in Tralee Bay, estimated at <3 per year. The Irish angler tagging and specimen catch data have recently been combined with effort data from charter angling vessels to explore the apparent extirpation of this species from two former hotspots: Clew Bay and Tralee bay. This study showed a decline close to zero, despite apparent stable or increasing angler effort (Figure 22.5; Shephard *et al.*, 2019).

22.6 Fishery-independent data

Angel shark is encountered very rarely in trawl surveys, which may reflect the low abundance of the species, poor spatial overlap between surveys and refuge populations and their preferred habitats, and low catchability in some survey gears.

Occasional individuals have been captured in the UK beam trawl survey in Cardigan Bay, but the gear used (4 m beam trawl with chain mat) is not thought to be suitable for catching larger angel sharks.

Existing surveys are not considered appropriate for monitoring the status of this species. Dedicated, non-destructive inshore surveys in areas of known or suspected presence could usefully be initiated.

22.7 Life-history information

Limited life-history data are available (Table 22.3). Most recent biological data have come from studies in the Canary Islands (e.g. Meyers *et al.*, 2017), where this species is found regularly. Life-history parameters were recently collated by Ellis *et al.* (2021).

22.7.1 Habitat

Angel shark is a coastal species that has often been reported from sand bank habitats, sandy areas close to reefs, and similar topographic features. This ambush predator buries into the sand for camouflage. Angel sharks are thought to be nocturnally active (Standora and Nelson, 1977).

In terms of recent information on their habitats, a potential over-wintering area may occur off Pembrokeshire (51°30' to 52°00'N and 5°03' to 6°03'W; Figure 22.3), small specimens have been reported in Cardigan Bay (summer) and the western coast of Ireland (particularly Tralee Bay) may be important "summer areas" for the species (Wögerbauer *et al*., 2014 WD). There are ongoing studies, coordinated by Zoological Society of London (ZSL) and Natural Resources Wales (NRW) to collate historic and recent sightings data around the Welsh coastline, especially Cardigan Bay.

22.7.2 Spawning, parturition and nursery grounds

No specific information. Angel sharks giving birth have been reported from parts of the North Sea (e.g. Patterson, 1905) and small specimens have been found in the inshore waters or Cardigan Bay. Information from other angel shark species elsewhere in the world suggests that there may be an inshore migration in early summer, with parturition occurring during the summer.

22.7.3 Age and growth

No information available for *Squatina squatina.* Studies on other species of angel shark have reported problems using vertebrae for validated age determination (Natanson and Cailliet, 1986; Baremore *et al*., 2009), with tagging studies providing some data (Cailliet *et al*., 1992).

22.7.4 Reproductive biology

Angel sharks give birth to live young. Patterson (1905) reported on a female (ca. 124 cm long) that gave birth to 22 young. Capapé *et al.* (1990) reported a fecundity of 8–18 (ovarian) and 7–18 (uterine) for specimens from the Mediterranean Sea. Embryonic development takes one year, but the reproductive cycle may be two (or more) years, as indicated by other members of the genus (Bridge *et al*., 1998; Colonello *et al*., 2007; Baremore, 2010).

22.7.5 Movements and migrations

Tagging data indicate high site fidelity (Capapé *et al*., 1990; Quigley, 2006; ICES, 2013). More than half of tagged angel sharks were recaptured less than 10 km from their original location, but individuals are capable of travelling longer distances within a relatively short window (Figure 22.4; Wögerbauer *et al*., 2014 WD). Occasional longer-distance movements have been reported, with fish tagged off Ireland being recaptured off the south coast of England and in the Bay of Biscay (Quigley, 2006).

Seasonal migrations are suspected, with fish moving to deeper waters in the winter before returning to inshore waters for the summer. Other species of angel shark have also been shown to move into coastal waters in the summer, typically to give birth (Vögler *et al.*, 2008).

The uncommon landing of about ten large individuals observed in 2000 from a French trawler fishing off southern Ireland, provide further evidence for localized aggregation of the species (S. Iglésias, *pers. comm.*).

22.7.6 Diet and role in the ecosystem

Angel shark is an ambush predator that predates on a variety of fish (especially flatfish) and various invertebrates (Ellis *et al.*, 1996, 2021).

22.8 Exploratory assessment models

An exploratory stock assessment of the Tralee Bay (Division 7.j) population, using data from the IFI Marine Sportfish Tagging Programme (Section 22.5.1), was undertaken (Bal *et al.,* 2014 WD; ICES, 2014). This was updated after review (Bal *et al.*, 2015 WD), with the approach, results and a discussion of the current state of the assessment presented in full in the WGEF 2015 report. In summary, Bal *et al*. (2015) suggested that the current population of angel shark around Ireland is very low compared to the whole historical time-series, although the actual population size remained uncertain. This trend was robust and indicated an important decline starting in the 1980s, concurring with anecdotal reports on angel shark abundance.

22.9 Stock assessment

Whilst no quantitative stock assessment has been benchmarked, due to data limitations, the WGEF perception of the stock is based largely on analyses of historical and contemporary trawl surveys.

Recent studies using recreational catch data have shown that the stock has declined dramatically in Clew and Tralee Bays - two former hotspots on the west of Ireland (Shephard *et al*., 2019). Angler catches of angel shark are now extremely rare at these locations, with only occasional anecdotal reports. Although it is not possible to conduct a quantitative stock assessment, it is evident that the species is in a critically poor state even in important areas of its original geographic range. The Irish Marine Institute is currently undertaking a multi-disciplinary research project on Angel shark in Tralee Bay, and this study may further clarify current stock abundance, as well as produce information on migration, nursery grounds, feeding etc.

Historically, coastal trawl surveys around the British Isles often reported angel shark, especially in the western English Channel (Garstang, 1903; Rogers and Ellis, 2000) and Bay of Biscay (Quéro and Cendrero, 1996). In contrast, contemporary surveys encounter this species only very infrequently, if at all. Such patterns have been reported elsewhere in the biogeographic range of angel shark (e.g. Jukic-Peladic *et al.*, 2001).

The apparent scarcity of angel sharks in contemporary trawl surveys is in stark contrast to early texts on British fishes, which generally considered that angel shark were encountered regularly in British seas. Indeed, Yarrell (1836) stated that "*It is most numerous on the southern coast of our island; but it is occasionally taken in the Forth, and some other parts of the east coast, particularly around Cromer and Yarmouth. It is common on the coasts of Kent and Sussex …It is also taken in Cornwall*".

Similarly, Day (1880–1884) wrote "*In the Firth of Clyde it is by no means uncommon… In fact it is common in the North Sea and Bristol Channel. Occasionally taken off Yorkshire and is common on the Dogger Bank… taken on the coasts of Kent and Sussex, Hampshire and common at all times along the south coast…Common in Cornwall*". Similar examples are also evident in other accounts (see Table 22.4 and Ellis *et al.*, 2021).

WGEF considers that the comparisons of historical data with the near-absence in recent data (landings, surveys, observer programmes, angling data) are sufficient to consider the species to be severely depleted in the Celtic Seas ecoregion and possibly extirpated from the North Sea ecoregion. Whilst its status in the Bay of Biscay and Iberian coastal waters is unknown, it is considered very rare, with only occasional individuals reported.

22.10 Quality of the assessment

No formal stock assessment has been undertaken.

22.11 Reference points

No reference points have been proposed for this stock.

22.12 Conservation considerations

Angel shark is listed as Critically Endangered, both globally on the IUCN Red List (Morey et al., 2019) and the European Red List (Nieto *et al.*, 2015), is listed on the OSPAR List of Threatened and Declining Species (OSPAR Commission, 2010) and is protected on the UK's Wildlife and Countryside Act (see Section 22.4).

Various organizations (including conservation bodies and academic departments) are developing an Eastern Atlantic and Mediterranean Conservation Strategy for angel sharks (see www.angelsharknetwork.com).

Angel shark was listed on both Appendices I and II of the Convention on the Conservation of Migratory Species of Wild Animals (CMS) at the 12th Meeting of the Conference of the Parties to (COP12) in 2017. Contracting Parties to CMS that are Range States (countries in the area of jurisdiction of which species occur) of species listed on Appendix I should prohibit the taking of such species, whilst the Appendix II listing indicates that international cooperation and agreements should be developed to aid the conservation and management of the listed species (https://www.cms.int/en/convention-text). Following the CMS listing, angel shark was subsequently, in 2018, added to Annex 1 of the CMS Memorandum of Understanding (MoU) on the Conservation of Migratory Sharks.

22.13 Management considerations

Angel shark is thought to have declined dramatically in the ICES area and Mediterranean Sea, as evidenced from landings data, survey information and the decline in the numbers tagged in Irish waters. The contemporary occurrence of angel shark in the southern parts of the ICES area and off the coasts of northwest Africa remains uncertain, whilst the Canary Islands have been considered as the last hotspot of the species (Meyers *et al.*, 2017).

Since ICES advised that this species should receive the highest protection possible, it has been listed as a prohibited species on European fishery regulations.

Dedicated, non-destructive surveys of areas of former local abundance would be needed to inform on current habitat and range, and to assess the possibilities of spatial management.

Given the perceived low productivity of this species and that they have shown high site fidelity, any population recovery would be expected to occur over a decadal time frame.

Improved liaison and training with the fishing industry is required to ensure that any specimens captured are released. National observer programmes encountering this species could usefully collect information on the vitality of discarded individuals.

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Table 22.1a. Angel shark in the Northeast Atlantic. Reported landings (t) for the period 1978–2004. French landings from ICES and Bulletin de Statistiques des Peches Maritimes. UK data from ICES and DEFRA. Belgian data from ICES. UK landings for 1997 considered to be misreported fish. Data for 2000 onwards updated during WGEF (2021).

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
Belgium	.	.	.	.	.	.	.	.	.	.	.
France	8	3	32	26	29	24	19	18.7	19.5	18	13
UK	.	.	.	.	.	.	.	.	.	.	.
Total	8	3	32	26	29	24	19	18.7	19.5	18	13

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Belgium	.	.	.	.	.	.	.	.	.	.	.
France	9	13	14	12	11	2	2	1	1	1	1
UK	.	.	.	.	.	2	1	1	.	.	.
Total	9	13	14	12	11	4	3	2	1	1	1

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Belgium	.	.	.	.	.	.	.	.	.	.
France	2	1	2	+	1	+	+	+	+	0.03
UK	.	.	(47)	.	.	0.04	0.01	0.02	.	.
Total	2	1	2	0	1	0.04	0.01	0.02	0	0.03

Table 22.1b. Angel shark in the Northeast Atlantic. Reported landings (t) for the period 2005–2019, following WHSHARK2 (ICES, 2016) and subsequent data calls. Revised UK landings for 2017–2018 in 2020.

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Belgium	.	.	.	.	.	.	.	.	.	.	.	.
France	1.03	0.40	0.74	0.27	1.60	1.40	0.97	1.22	0.02	0.01	0.53	0.03
UK	0.06	0.04	0.01	.	.	.	.	.	.	.	.	.
Total	1.09	0.44	0.75	0.27	1.60	1.40	0.97	1.22	0.02	0.01	0.53	0.03

	2017	2018	2019	2020
Belgium	.	.	.	.
France	0.02	0.00	.	.
UK	0.13	0.02	0.08	.
Total	0.15	0.02	0.08	0

Table 22.2. Angel shark in the Northeast Atlantic. Numbers of specimen angel shark (total weight >22.68 kg) reported to the Irish Specimen Fish Committee from 1958–2005.

Year	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
No. specimen fish reported	3	1	0	0	4	1	15	13	5	13	0	2

Year	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
No. specimen fish reported	1	3	3	1	4	2	1	5	4	10	5	10

Year	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
No. specimen fish reported	7	3	2	2	0	1	1	2	2	2	1	3

Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
No. specimen fish reported	2	1	0	1	1	0	0	0	2	0	0	0

Table 22.3. Angel shark in the Northeast Atlantic. Summary of life-history parameters for *Squatina squatina*.

Common name	Angel shark
Scientific name	*Squatina squatina*
Stock unit	Unknown

The stock structure is unknown, but available data for this and other species of angel sharks indicates high site fidelity, possibly with localized stocks. STECF (2003) noted that angel sharks "*should be managed on smallest possible spatial scale*". However, given that angel shark is perceived as highly threatened throughout the ICES area (and elsewhere in European waters), ICES provide advice at the species level.

Length–weight relationship	$W = 0.021.L^{2.8269}$ (n = 24)			Ellis *et al.* (2021)
Reproductive mode	Aplacental viviparity			Capapé *et al.* (1990)
Reproductive cycle	Possibly biennial, based on data for congeneric species			Baremore (2010)
Spawning season	Parturition: Summer (possibly June to July)			Quigley (2006)
Fecundity (ovarian)	8–18 (mode = 13)			Capapé *et al.* (1990)
Fecundity (uterine)	8–18 (mode = 13) in the Mediterranean Up to at least 22 in the Atlantic			Capapé *et al.* (1990) Patterson (1905)
Development (months)	Annual			Capapé *et al.* (1990)
Length at birth/hatching	25–28 cm			Capapé *et al.* (1990)
Maximum length	244 cm			Quigley (2006)
	Female	**Male**	**Combined**	
Length of smallest mature fish	128 cm	80 cm (?)	–	Capapé *et al.* (1990)
Length at 50% maturity	–	–	–	–
Length of largest immature fish	–	–	–	–
Age at 1st maturity	–	–	–	–
Age at 50% maturity	–	–	–	–
Age at 100% maturity	–	–	–	–
L_{inf}	–	–	–	–
K	–	–	–	–
t_0	–	–	–	–
Maximum age (years)		–		–
Trophic role	Ambush predator that feeds on fish, including flatfish, and larger crustaceans (Ellis *et al.*, 1996)			

Table 22.4. Angel shark in the Northeast Atlantic. Regional chronology of perceived status of angel shark.

Area	Description
Southern North Sea	Laver (1898) "*This frequents the entire Essex coast. It is usually caught in nets. Though occasionally eaten by fishermen, it is according to my taste, far too rank in flavour for a more delicate palate*" Murie (1903) "*The 'fiddlers' are got all round the Kent coast in moderate quantity, but Webb regards it as somewhat of a rarity just at Dover. It is not a common fish in the Thames estuary, in one sense, though there are seasons when it is very frequently got in the trawlers' nets. In 1893 they were unusually plentiful during the summer months in the neighbourhood of the Oaze, Girdler, Gilman, and so called S. Channel generally. From June till August there were few boats but had examples among their catch, and some of the specimens were of large size*" Patterson (1910) "*has been brought into* (Lowestoft) *on several occasions*" Poll (1947) wrote "*Espècie commun, surtout en été*" [A common species, especially in summer]
English Channel	Buckland (1881) "*found in the North Sea, the British Channel, the Mediterranean … It is taken on the 'long lines' which are set for ray, &c … It is common on the bays of Archachon and, I believe, on the sandy banks all along the Bay of Biscay. They are frequently seen in the markets of Dieppe, and are not uncommon at Brighton and Hastings*" Aflalo (1904) "*familiar on most parts of the coast, and is a frequent object of unintentional capture on the long-lines, as well as in both trawl and drift-nets … Small examples of from 12 to 18"are common in many south coast estuaries, notably at Teignmouth, where a few are brought ashore almost every week during May in the sand-eel seines worked just outside the bar*" Le Danois (1915) "*à Roscoff, assez commun vers la fin de l'été*" [At Roscoff, it is quite common in late summer] Cooper (1934) "*Several specimens of this species are caught every year by anglers, usually when Tope fishing, but it appears to have been more common on the south coast of England some twenty or thirty years ago than it is today*" MBA (1957) "*A haul of the trawl in Cawsand Bay will generally yield several specimens. Occasionally trawled on other grounds*"
Irish Sea Ireland	Herdman and Dawson (1902) "*common off our coasts in spring and summer. It occurs not infrequently in the trawl net in the Lancashire district. We have taken it as near Liverpool as the Rock and Horse Channels, and the Deposit Buoy. We have also taken it near Piel in the Barrow Channel, and off Maughold Head. Mr Walker records it from Rhos weir and Colwyn Bay, and Professor White from the Menai Straits. It has been frequently taken off the Isle of Man, one is recorded from Port Erin, and we have taken it also in the Ribble, and have seen it taken on the offshore grounds by the trawlers*" Forrest (1907) "*… frequently met with it off Aberffraw … from Barmouth … not uncommon in the Menai Straits, Colwyn Bay and along the north coast …* (taken in) *St Tudwal's Roads, Red Wharf Bay, and other places*" Williams (1954) "*Taken rather infrequently off Strangford Bar. Said to be common off the north shore of Ireland"* Went & Kennedy (1976) listed it as common noting that it was "*more often caught on rod and line than by any other method*"

Table 22.4. (continued). Angel shark in the Northeast Atlantic. Regional chronology of perceived status of angel shark.

Area	Description
France (Bay of Biscay and Mediterranean)	Moreau (1881) "*L'Ange se trouve sur toutes nos côtes, mais il paraît plus commun dans l'ocean que dans la Méditerranée, il est même assez rare à Cette*" [Angel shark is on all our coasts, but it seems more common in the (Atlantic) ocean than in the Mediterranean, it is quite rare at Séte] Quéro *et al*. (1989) recorded individual fish from trawl surveys, including one from coastal waters near Pornic (just south of the Loire Estuary) in 1973 and one further offshore south-west of the mouth of the Gironde in 1975
Spain	Lozano Rey (1928) reported that angel shark "*vive en todo el litoral ibérico, aunque parece más frecuente en las costas del Atlántico que en las del Mediterráneo, pero en este tampoco es rara … Los individuos jóvenes se pescan en la misma orilla. Nosotros hemos capturadao ejemplares de este especie, de menos de treinta centímetros de longitude, en la bahía de Santander, a un par de metros de profundidad*" [lives all along the Iberian coast, although it seems more common in the Atlantic coasts than in the Mediterranean, but this is not unusual ... Young individuals are caught in the same bank. We have captured specimens of this species, less than 30 cm long, in the Bahía de Santander, in waters a few meters deep] In relation to the Bahía de Santander, García-Castrillo Riesgo (2000) noted "*Hoy en día, esta especie de angelote no está presente en el entorno de la Bahía. La última referencia que tenemos data de 1985, cuando se recogió un ejemplar adulto y moribundo en el Puntal. Por el contrario a principios de siglo, según los datos de la Estación Biólogica de Santander, los jovenes eran frecuentes en los arenales del Puntal, el sable de Afuear, Enmedio y el fondeadero de la Osa, siendo aún más abundantes en al Abra del sardinero y las Quebrantas*". [Today, this kind of angelfish is not present in the environment of the Bahía. The last reference we have dates from 1985, when a dying adult specimen was collected in the Puntal. Rather early in the century, according to data from the Biological Station of Santander, the young were frequent off the beach at Puntal, saber Afuear, Enmedio and the anchorage of the Osa, still more abundant in the Abra del Sardinero and Quebrantas]
Portugal	Nobre (1935) wrote "*Esta espécie aparece freqüentemente no norte do País, sendo apanhada nas rêdes de fundo*" [This species appears frequently in the north of the country, where it is caught in bottom nets]
Italy	Tortonese (1956) stated it was "*Più o meno commune in tutti i nostri mari*" [more or less common in all our seas]

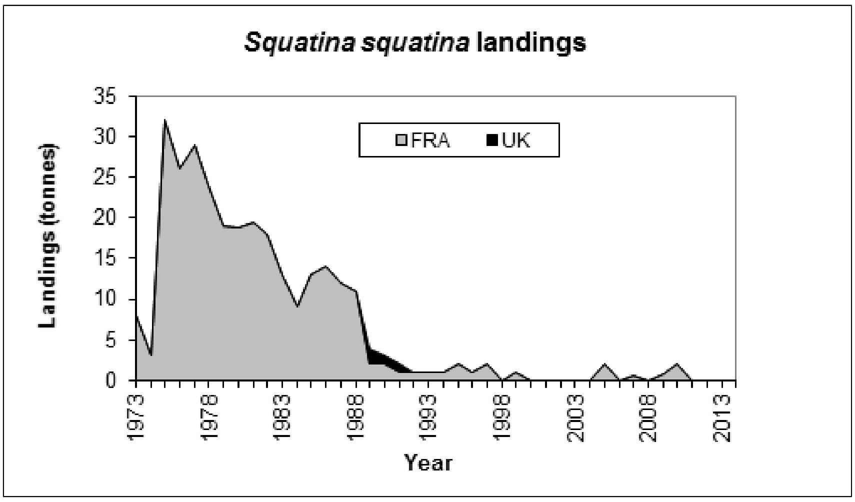

Figure 22.1. Angel shark in the Northeast Atlantic. Total reported landings of *Squatina squatina* (1973–2012). Angel shark has been listed as a non-retained/prohibited species on European fisheries regulations since 2009 and so this species is now reported very rarely in landing statistics.

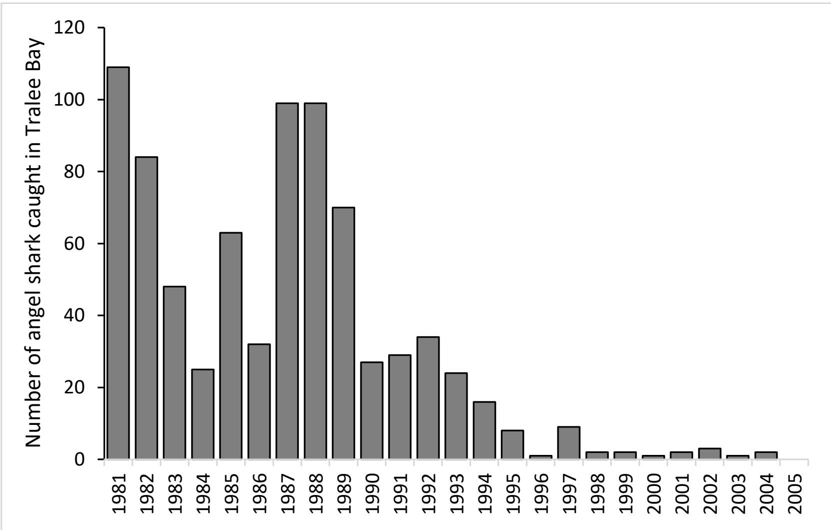

Figure 22.2. Angel shark in the Northeast Atlantic. Numbers of angel shark caught by two charter boats in Tralee Bay 1981–2005. Adapted from Irish Central Fisheries Board data presented in ICES (2008).

Figure 22.3. Angel shark in the Northeast Atlantic. The suspected over-wintering area off Pembrokeshire, where occasional individuals have been reported by French vessels.

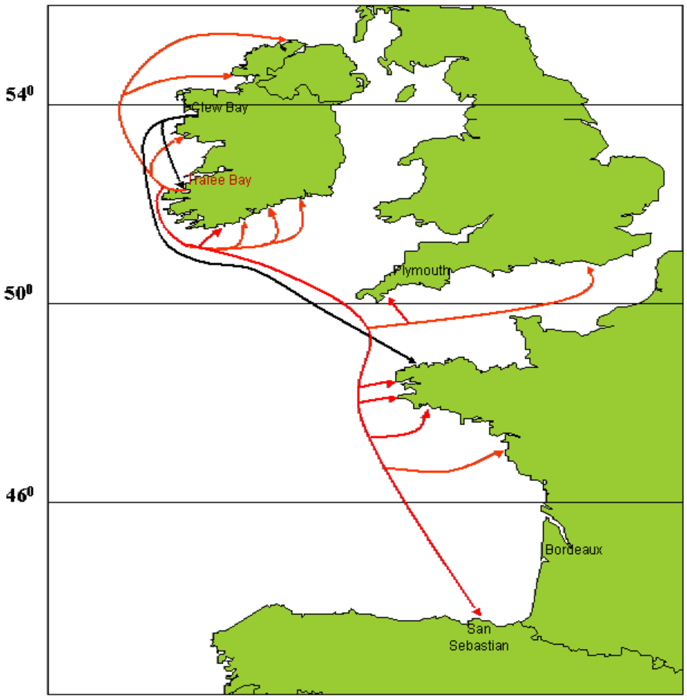

Figure 22.4. Angel shark in the Northeast Atlantic. Longer-distance movements of angel shark tagged off the west coast of Ireland, 1970–2006. Source: Irish Central Fisheries Board.

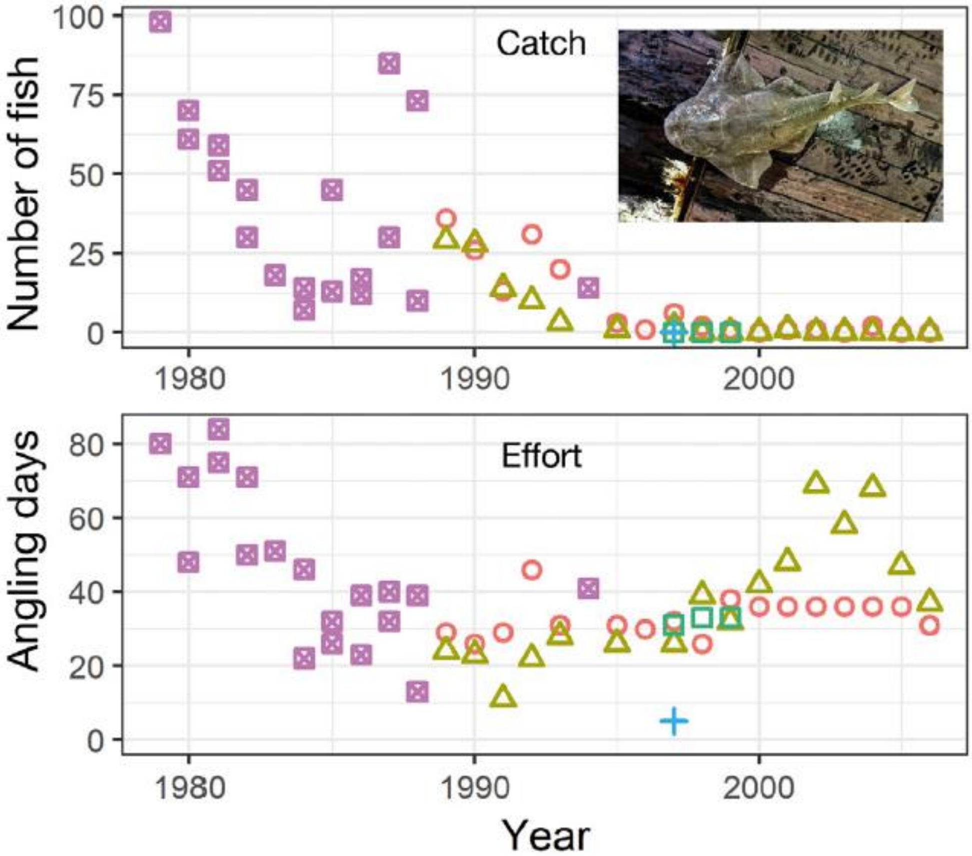

Figure 22.5. ***Squatina squatina*** **annual angling catch and effort for charter vessels in Tralee Bay, Ireland. Inset photograph of** ***S. squatina*** **(100 cm total length) caught and released alive from FV 'Eblana' in 2016. Colours of the data points refer to different vessels. Figure from Shephard** ***et al*****. (2019).**

23 White skate *Rostroraja alba* in the Northeast Atlantic

23.1 Stock distribution

White skate *Rostroraja alba* is distributed in the eastern Atlantic from the British Isles to southern Africa, including the Mediterranean Sea (Stehmann and Bürkel, 1984). As such, the species distribution covers parts of ICES subareas 7–9, and may possibly have extended into the southern parts of subareas 4 and 6.

The stock structure within the overall distribution area is unknown. This data-limited species is perceived as threatened throughout the ICES area (and elsewhere in European waters), and ICES provides advice at the species level.

23.2 The fishery

23.2.1 History of the fishery

R. alba is thought to have been the subject of targeted exploitation for much of the 19th and early 20th centuries, with targeted fisheries in the English Channel, Brittany and possibly the Isle of Man (Irish Sea). It was viewed as a highly marketable skate due to its large size and thickness of the wings (Ellis *et al.*, 2010).

In 1964, 59 tonnes of *R. alba* was landed in the port of Douarnenez (Brittany) from a target longline fishery (Du Buit, *pers. comm.*). After this, the fishery and local stock collapsed. The use of the landing name 'Raie blanche' (white skate) is now discontinued in French fish markets and only known by the oldest fishermen and fish-market workers. Up to 2009, only occasional individuals were landed in France, often under the name '*Dipturus batis*'. It was estimated that 13 ±10 individuals (117 ±89 kg) were landed in 2005 in France under the name '*D. batis*'. During a sampling programme of large skates in French ports (2006–2007), only one *R. alba* specimen was positively identified from the 4110 skates examined (Iglésias *et al.*, 2010). Prior to the inclusion of *R. alba* on the EU prohibited list, individuals were recorded occasionally in Portuguese landing ports (Serra-Pereira *et al.*, 2011).

R. alba may be a very occasional bycatch in some trawl and gillnet fisheries, although as a prohibited species the caught individuals should be released. There was an authenticated record of an individual caught (and released) in the English Channel (in 2013). As the species is largely unknown by fishermen and does not have highly conspicuous morphological characters for its identification, individuals might occasionally be mixed with other skates.

23.2.2 The fishery in 2020

No new information.

23.2.3 ICES Advice applicable

In 2014, ICES advised "*on the basis of the precautionary approach … there be no catches of this species. Measures should be taken to minimize bycatch to the lowest level*". ICES (2014) also stated that "*Rostroraja alba is designated on the EU prohibited species list in the entire ICES area. This is a high-level,* *long-term conservation strategy aimed at very depleted and vulnerable species. ICES supports this listing, having reviewed it in 2010*".

In 2016, ICES advised that "*when the precautionary approach is applied, there should be zero catches of this species in each of the years 2017, 2018, and 2019.*"

In 2019, ICES advised the precautionary approach with zero catches of this species in each of the years 2020, 2021, 2022, and 2023.

23.2.4 Management applicable

Council Regulation (EC) 2017/127 continues to prohibit European Union vessels to fish for, to retain on board, to tranship or to land *R. alba* in Union waters of ICES subareas 6–10. Council Regulation (EC) 2018/120 also states that *"when accidentally caught, species…shall not be harmed"* and *"specimens shall be promptly released".* This prohibited status has been in force since 2009.

Regulation (EU) 2015/812 requires that all white skate caught and discarded should be reported.

R. alba is legally protected in UK waters, being listed on the Wildlife and Countryside Act.

23.3 Catch data

23.3.1 Landings

R. alba became increasingly rare in landings prior to the requirements for species-specific recording (Ellis *et al.*, 2010), and so there is great uncertainty on historical levels of exploitation.

Some of the nominal landings reported for *R. alba* are thought to refer to either other large-bodied skates (*Dipturus* spp.) or shagreen ray *Leucoraja fullonica*, as this species also has a sharply pointed snout. In addition to possible misidentifications, there are likely input errors, especially as the FAO code for Rajidae (RAJ) could easily be input as RJA (*R. alba*).

Landings from around Scotland are assumed to refer to *L. fullonica,* and landings from other areas outside the former distribution have been assigned to Rajiformes (see ICES, 2016). Other nominal landings of *R. alba* (Table 23.1) may still be unreliable.

Landings from France under the FAO code RJA, *Rostroraja alba* are corrected into RAJ as those landings data refer to a mixture of species such as *Amblyraja radiata*, *Rajella lintea*, *Bathyraja spinicauda*, *Rajella fyllae* and *Amblyraja hyperborea*.

23.3.2 Discards

Limited data are available. The discard observer programme for the English and Welsh fleets did not record any *R. alba* (Silva *et al.*, 2012). The Portuguese Pilot Study for Skates recorded single specimens of *R. alba* (47 and 62 cm L_T) in two trips using trammel nets, from a total of 20 fishing trips and a total sample of 667 skates. There is uncertainty in the reliability of some nominal records of *R. alba* recorded in other national observer programmes.

23.3.3 Quality of catch data

Both landings and discard data for *R. alba* are very limited and may be confounded with other species. The nominal landings presented are considered unreliable

23.3.4 Discard survival

There are no species-specific data on the discard survival of *R. alba*. Discard survival of skates has been examined for a range of other skate species, with at-vessel mortality low in some inshore fisheries, but more limited data available for post-release mortality (Ellis *et al.*, 2017). The two specimens recorded in the EU/PNAB observer trips were considered in "good" health condition (following Enever *et al*., 2009).

23.4 Commercial catch composition

No data available.

23.5 Commercial catch and effort data

No data available.

23.6 Fishery-independent information

R. alba is encountered very rarely in trawl surveys, which may reflect the low abundance of the species and/or poor spatial overlap between surveys and refuge populations and/or their favoured habitats. Existing surveys are not considered appropriate for monitoring the status of this species.

Although not taken in English trawl surveys (Ellis *et al*., 2005), occasional individuals have been captured in the Irish Groundfish survey along the west coast of Ireland. One egg-laying female (185 cm L_T) was caught in the Portuguese Groundfish Survey in 2007.

23.7 Life-history information

Although taken periodically along the west coast of Ireland (Quigley, 1984), the biology of this species in northern European seas is largely unknown. It has been better studied in the Mediterranean Sea (Capapé, 1976; 1977). Kadri *et al.* (2014) examined specimens from the Mediterranean: the smallest mature fish were 110 cm (male) and 120 cm (female). The youngest mature female in this study was estimated to be 17 y, and the oldest fish 35 y.

R. alba egg cases are occasionally found in Galway Bay and Tralee Bay in the West of Ireland (G. Johnston, pers. comm.).

French fishers consider this species to live preferentially on harder substrates, and so it may have been caught more frequently in static set nets and longline fisheries (Iglésias, pers. comm.).

Recent acoustic monitoring collected information on movement patterns of three *R. alba* within a protected area in the West coast of Portugal (Sousa *et al*., 2019). A mature female (138 cm) stayed in the area for 20 months while the two others, which are immature, moved from the area after three to four months. The three skates displayed daily patterns of activity being more mobile at sunset and sunrise with a relatively low activity during day light. They also seem to spend more time in deeper water but the mature female was also detected at shallower depth during spring and summer.

23.8 Exploratory assessment models

No exploratory assessments have been undertaken.

23.9 Stock assessment

No formal stock assessment has been undertaken. The perceived stock status is based on the comparison between recent and historical trawl survey catch data.

Historically, trawl surveys around the British Isles reported *R. alba* (Rogers and Ellis, 2000), whereas it has now disappeared from parts of their former range. Similar longer-term declines have also been reported for the Bay of Biscay (Quéro and Cendrero, 1996).

WGEF considers that the comparison of historical data with the near-absence in recent data sources (historical landings, surveys, observer programmes) is sufficient to consider the species to be severely depleted and near-extirpated from various parts of the Celtic Seas and Biscay-Iberian ecoregions.

23.10 Quality of the assessment

No formal stock assessment has been undertaken.

23.11 Reference points

No reference points have been proposed for this stock.

23.12 Conservation considerations

R. alba is listed as Critically Endangered on the IUCN Red List (Gibson *et al.*, 2008; Nieto *et al.*, 2015). It is listed on the OSPAR List of Threatened and Declining Species (OSPAR Commission 2010). It is protected on the UK's Wildlife and Countryside Act.

R. alba is listed as a prohibited species for which there is a prohibition to fish for, retain on board, tranship, land, store, sell, display or offer for sale Union waters of ICES subareas 6-10 in Regulation (EU) 2019/1241, this regulation has been consolidated the 01/01/2021.

In 2020, WKSTATUS reviewed and updated the OSPAR status assessments of *R. alba*. Experts specified that there is no information suggesting an improvement in the status of this stock since 2010, the year of the last assessment. Therefore, the species continues to justify inclusion in OSPAR List (ICES, 2020).

23.13 Management considerations

Since ICES advised that this species should receive the highest protection possible, it has been listed as a prohibited species on EC fishery regulations.

Given the low abundance of this species and its high conservation interest, WGEF recommend that (i) any data on *R. alba* collected from national observer programmes be verified whenever possible (e.g. photographed) and (ii) that ongoing national observer programmes collect information on the health state (e.g. lively, sluggish, dead) of any discards of this species.

Dedicated, non-destructive surveys of areas of former abundance would be needed to inform on current habitat and range.

Given the perceived low productivity of this species, any population recovery would take a decadal time frame.

As this species could be overlooked in catches of mixed skates, improved identification material could usefully be developed.

Although, regulation requires any catch to be reported, it is highly probable that fishers cannot identify this species as they rarely encountered it.

23.14 References

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Table 23.1. White skate in the Northeast Atlantic. Nominal landings of *R. alba* in the ICES area. Some national data reported as white skate have been reassigned to Rajiformes (indet.) or *L. fullonica* (see ICES, 2016). The accuracy of remaining data (below) is unclear, due to possible input errors for the codes RAJ (Rajidae) and RJA (*Rostroraja alba*).

Year	France	Ireland	Portugal	UK	Total
2005	1	-	4.65	-	5.65
2006	-	-	5.51	-	5.51
2007	1.52	-	-	-	1.52
2008	0.73	-	-	0.95	1.68
2009	59.35	-	-	0.09	59.44
2010	10.65	-	-	0.06	10.72
2011	29.16	-	-	-	29.16
2012	12.1	-	-	0.22	12.32
2013	14.92	-	-	0.01	14.93
2014	11.29	0.26	-	0.1	11.65
2015	7.47	0.02	-	-	7.48
2016	4.25	0.12	-	-	4.36
2017	3.9	-	-	0.13	4
2018	7.1	0.4	-	-	7.5
2019	-	0.12	-	-	0.12
2020	-	-	-	0.08	0.08

24 Greenland shark *Somniosus microcephalus* in the Northeast Atlantic

24.1 Stock distribution

The known North Atlantic distribution of Greenland shark *Somniosus microcephalus*, which has been defined primarily by observations of specimens caught in cold-water commercial fisheries, extends from temperate waters to the Arctic Ocean (MacNeil *et al.*, 2012). It ranges from Georgia (USA) to Greenland, Iceland, Spitzbergen and the Arctic coasts of Russia and Norway to the North Sea and Ireland, with only very occasional individuals recorded further south (Ebert and Stehmann, 2013). Due to their known tolerance for extreme cold water and their ability to inhabit abyssal depths, Greenland sharks may be more widespread. The known distribution is also compromised by taxonomic problems in this genus (MacNeil *et al.*, 2012). The metapopuation structure is unknown.

24.2 The fishery

24.2.1 History of the fishery

Fishing for Greenland shark has been a part of the Scandinavian, Icelandic and Inuit cultures for centuries, extending back to the 13th and 14th century in Norway and Iceland, respectively. Although the meat of Greenland shark may be toxic when fresh (e.g. Anthoni *et al.*, 1991; McAllister, 1968), it is eaten in some countries after curing.

In the early to mid-20th century, Greenland sharks were caught in large quantities as a source of liver oil. At that time, peak annual catches e.g. in Norway are thought to have been in the order of 58 000 individuals (Ebert and Stehmann, 2013; MacNeil *et al.*, 2012). After the invention of synthetic oil in the late 1940s, demand for shark oil diminished, and no intensive fisheries for Greenland sharks have been reported since (Nielsen *et al.*, 2014).

Greenland shark is still targeted in small-scale artisanal fisheries in Iceland and Greenland. Artisanal fisheries target Greenland shark with hook and line, longline or gaffs, but it is also taken in seal nets and cod traps (Ebert and Stehmann, 2013). It is also an occasional bycatch in longline, trawl and gillnet fisheries in the cooler waters of the North Atlantic.

24.2.2 The fishery in 2020

No specific changes in the fishery were apparent in 2020. Apart from Iceland, no countries have reported landings since 2016. Iceland reported landings of 17, 9, 6 and 16 tonnes in 2017, 2018, 2019 and 2020, respectively.

24.2.3 ICES Advice applicable

ICES has not been asked to provide advice on Greenland shark.

24.2.4 Management applicable

In 2016, Regulation (EU) 2016/2336 specified conditions for fishing for deep-sea stocks in the north-east Atlantic and provisions for fishing in international waters of the north-east Atlantic and included the Greenland shark to the list of deep-sea sharks on EC quota regulations for deep-sea fishes. There is a zero TAC for deep-sea sharks in EU vessels fishing in Union and international waters of ICES subareas 5–10 (EC, 2015).

24.3 Catch data

24.3.1 Landings

Limited landings data are available. More comprehensive landings data are only available from Iceland (www.hagstofa.is and Marine Freshwater Research Institute databases). Reported annual landings by Iceland (Table 24.1) from ICES Division 5.a and Subarea 14 have varied from about 2 tonnes (2007) to 87 tonnes (1998). Monthly Icelandic landings of Greenland shark (2005–2020) indicate a peak during the late spring and summer months (Figure 24.1).

24.3.2 Discards

Limited data are available. Greenland shark is a bycatch in trawl fisheries for Greenland halibut *Reinhardtius hippoglossus* and northern shrimp *Pandalus borealis*, as well as in gillnet and longline fisheries (MacNeil *et al.*, 2012; Nielsen *et al.*, 2014).

In the Barents Sea, bycatch of Greenland shark in bottom trawls were related to sea temperature, with more bycatch at lower water temperatures (Rusyaev and Orlov, 2013). Despite limited data on Greenland shark bycatch in the commercial trawl fishery, Rusyaev and Orlov (2013) estimated an annual catch of 140–150 tonnes in the Barents Sea.

In local fishing communities in Greenland, Greenland shark accounts for 50% of the total waste produced by the fishing industry. Estimated annual amounts of waste products of Greenland shark from fishing and hunting in specific counties may be *ca.* 1000 tonnes (Gunnarsdóttir and Jørgensen, 2008).

24.3.3 Quality of catch data

As observers are not mandatory in the fisheries that may have a bycatch of Greenland shark, bycatch levels are uncertain. In some areas there may be confusion with other members of the genus or even basking sharks (MacNeil *et al.*, 2012).

24.3.4 Discard survival

No estimates on discard survival are available for this species. According to on-board observers, some Greenland sharks caught in offshore trawl and longline fisheries are released alive (MacNeil *et al.*, 2012).

Studies with electronic tags have indicated that another deep-water shark, the leafscale gulper shark *Centrophorus squamosus*, one of the species occurring in European seas, can survive after being caught by longline (2–3 h soak time) from waters of 900–1100 m (Rodríguez-Cabello and Sánchez, 2014). Quantified data on the at-vessel mortality (AVM) and post-release mortality (PRM) of deep-water sharks that may be a by-catch in existing deep-water commercial fisheries are currently lacking (Ellis *et al.*, 2016).

24.4 Commercial catch composition

No information available.

24.5 Commercial catch and effort data

No information available.

24.5.1 Recreational CPUE data

There are recreational catch and release fisheries for Greenland sharks in Norway (year-round) and Greenland (in March) (MacNeil *et al.*, 2012), but CPUE data are not available.

24.6 Fishery-independent information

Greenland sharks are caught regularly during gillnet and bottom-trawl surveys around Greenland, such as the Greenland Institute of National Resources Annual bottom trawl survey (Nielsen *et al.*, 2014). Irregular catches are also reported from the annual German Greenland groundfish survey (71 individuals between 1981 and 2019, Figure 24.2). Trawl surveys conducted in the Barents Sea also encounter Greenland shark. Occasional catches are also reported in various Icelandic surveys, but with a total of just 68 observations over the period 1936–2012.

Existing scientific surveys are not appropriate for monitoring the abundance of Greenland sharks in their distribution area because catches are rare.

24.7 Life-history information

24.7.1 Habitat and abundance

Greenland sharks show a marked preference for cold water with most observations from waters of -1.8 to 10°C and the majority of records from waters <5°C (Skomal and Benz, 2004; Stokesbury *et al.*, 2005; Fisk *et al.*, 2012; MacNeil *et al.*, 2012). They occur on continental and insular shelves and upper slopes (Ebert and Stehmann, 2013). Confirmed observations cover a broad depth range from abyssal depths of at least 1560 m (Fisk *et al.*, 2012) to shallow water (Yano *et al.*, 2007; MacNeil *et al.*, 2012). Devine *et al*. (2018) found that off the northern Canadian coast, shark densities peaking at intermediate temperatures sampled, and at depths between 450–800 m. Though primarily considered a demersal species, it may be caught both at the surface and in the pelagic zone (e.g. Stokesbury *et al.*, 2005; MacNeil *et al.*, 2012). They often associate with fjord habitats (MacNeil *et al.*, 2012).

Using baited remote underwater video cameras, Devine *et al*. (2018) calculated Greenland shark abundance and biomass in Arctic Canada. Density estimates varied from 0.4 to 15.5 individuals per km^2 (biomass: 93.3–1210.6 kg per km^2) among regions; being highest in warmer (>0 °C), deeper areas and lowest in shallow, sub-zero temperature regions.

24.7.2 Spawning, parturition and nursery grounds

The only captures of Greenland shark with near-term embryos were near fjords in the Faroe Islands. Based on observations on two presumed neonatal specimens captured by mid-water trawl off Jan Mayen Island, Kondyurin and Myagkov (1983) suggested that parturition may occur in the Norwegian Sea in July–August. Specimens of presumed neonatal size have also been reported from Canadian, Norwegian and Greenland fjords (Bjerkan and Koefoed, 1957).

24.7.3 Age and growth

Greenland shark is the second largest shark in the ICES area and the largest fish inhabiting Arctic seas (Ebert and Stehmann, 2013). Bigelow and Schroeder (1948) reported a maximum size of 640 cm L_T and weight of 1023 kg. Females may attain a larger size than males. The growth rate of Greenland sharks is unknown, but observations from tagging experiments indicate growth rates of 0.5–1 cm y^{-1} (Hansen, 1963). Conventional vertebral ageing methods are not applicable for Greenland shark (MacNeil *et al.*, 2012). However, a recent study using radiocarbon analysis from eye lenses suggests that Greenland sharks live to be several hundred years-old (Nielsen *et al.*, 2016).

24.7.4 Reproductive biology

The Greenland shark is an aplacental viviparous species (Carrier *et al.*, 2004; Ebert and Stehmann, 2013). The exact size at birth as well as the gestation period remain unknown, but size at birth is thought to be *ca.* 40–100 cm L_T (MacNeil *et al.*, 2012). Size-at-maturity is difficult to determine. The onset of maturity in male Greenland sharks probably occurs at *ca.* 260 cm L_T but is variable, and males may reach maturity at *ca.* 300 cm L_T (Yano *et al.*, 2007). Females from Icelandic waters mature at 355–480 cm L_T (MacNeil *et al.*, 2012). Based on changes in ovary weight, Yano *et al.* (2007) suggested that females matured at >400 cm L_T. Nielsen *et al.* (2016) suggested the age at sexual maturity to be at least 156 ± 22 years. Fecundity is uncertain, but has been suggested to be approximately ten (Bjerkan and Koefoed, 1957; Ebert and Stehmann, 2013; Carter and Soma 2020); however, Nielsen *et al.* (2020) suggested a much larger fecundity, estimating up to 200–324 pups per pregnancy (depending on maternal size) with a body length-at-birth of 35–45 cm.

24.7.5 Movements and migrations

Studies using conventional and electronic (satellite and acoustic) tags have informed on the movements and migrations of Greenland sharks. Recent studies deploying archival pop-off tags (PATs) have shown that sharks display a broad vertical distribution, but no obvious diel movements were noted (Campana *et al.*, 2015; Fisk *et al.*, 2012). Tagged sharks move into deeper water when they mature, and it is possible that they migrate offshore to mate and/or give birth (Campana *et al.*, 2015). A recent study revealed a previously unknown directed migration from Canadian Arctic to NW-Greenland (Hussey *et al.* 2018). Previous studies have also examined the behaviour of Greenland sharks in the Northwest Atlantic (Skomal and Benz, 2004; Stokesbury *et al.*, 2005). All such studies have found examples of localized movements and site fidelity, as well as some larger scale movements.

24.7.6 Diet and role in ecosystem

Greenland sharks feed on a wide variety of invertebrates, fish and marine mammals, indicating they are generalist predators on both benthic and pelagic organisms (MacNeil *et al.*, 2012; Nielsen *et al.*, 2014), and they are important predators in Arctic food webs (Leclerc *et al.*, 2012). They are also important scavengers, including of whales (Leclerc *et al.*, 2011). Recent studies showed an ontogenetic dietary shift with small sharks (<200 cm) mainly feeding on lower trophic level prey such a squid, while larger sharks feed on seals as well as epibenthic and benthic fishes. Additionally, it was indicated that Greenland sharks are capable of active predation on fast swimming mammals and large fishes (Nielsen *et al.*, 2019).

24.8 Exploratory assessment models

No exploratory stock assessments have been undertaken.

24.9 Stock assessment

No stock assessment has been undertaken.

24.10 Quality of the assessment

No stock assessment has been undertaken.

24.11 Reference points

No reference points have been proposed for this stock.

24.12 Conservation considerations

On the basis of possible population declines and limiting life-history characteristics, the Greenland shark is listed as Vulnerable in the IUCN Red List (Kulka *et al.*, 2020). It is listed vulnerable in the Swedish Red List of endangered species (Svensson *et al.*, 2010).

24.13 Management considerations

Stock status and many other aspects of the biology of Greenland sharks are unknown. Given the large body size of this species and perceived low population productivity, further studies to better understand population dynamics and sources of mortality are required.

Ruud (1968) reported a longer-term decline in Greenland shark in the Oslofjord, but it is unclear as to how such local depletions towards the south of the distribution range relate to wider population trends.

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Table 24.1. Greenland shark *Somniosus microcephalus* in the Northeast Atlantic. Preliminary estimates of landings (t) for the period 1992–2020). Data were updated with landings from ICES historic nominal landings database (ICES, 2016) and national landings data provided to the WG (June 2021).

Year	Iceland	Greenland	Portugal	Sweden	Total
1992	68				68
1993	41				41
1994	42				42
1995	43				43
1996	61				61
1997	73				73
1998	87				87
1999	51				51
2000	45				45
2001	57				57
2002	56				56
2003	55				55
2004	58				58
2005	50		0.3		50
2006	28		0.5		29
2007	2	17	0.7		20
2008	42		0.6		43
2009	26			0.4	26
2010	43				43
2011	18				18
2012	19				19
2013	6				6
2014	60	8			68
2015	28	17			45
2016	26				26
2017	17				18
2018	9				8
2019	6				6
2020	16				

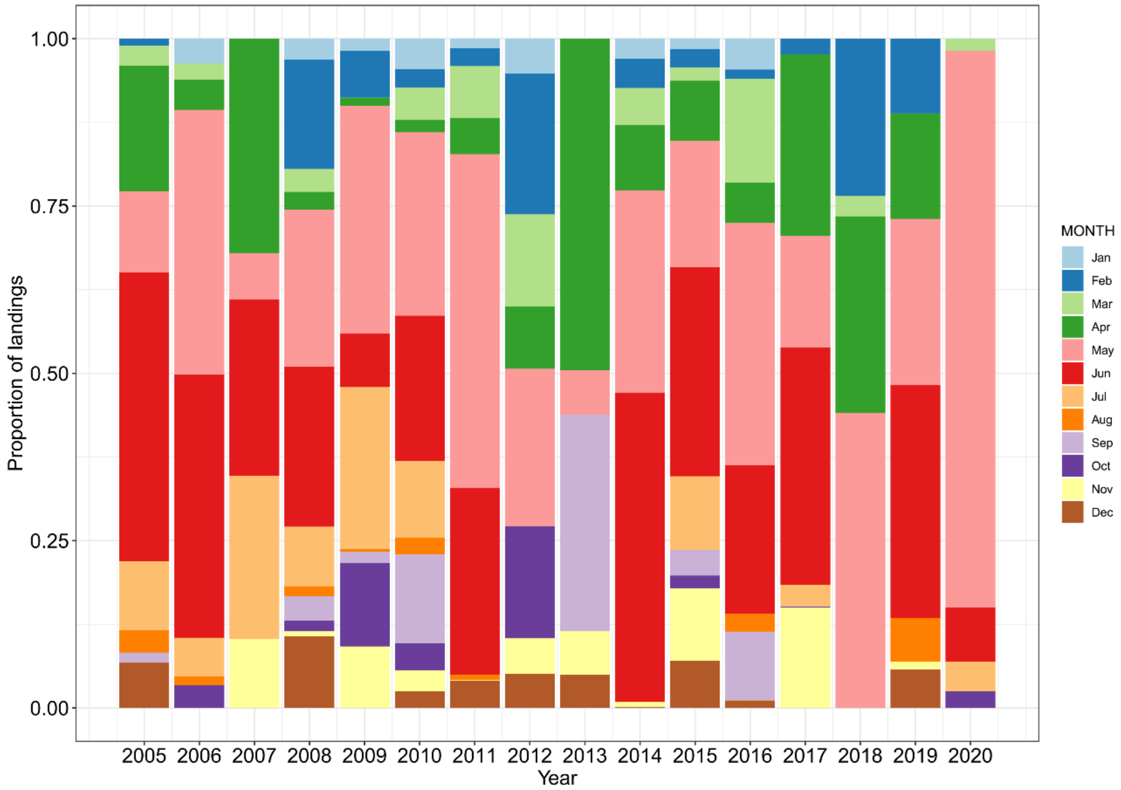

Figure 24.1. Greenland shark (*Somniosus microcephalus*) in the Northeast Atlantic. Monthly Icelandic landings of Greenland shark 2009–2020. Data from www.hagstofa.is

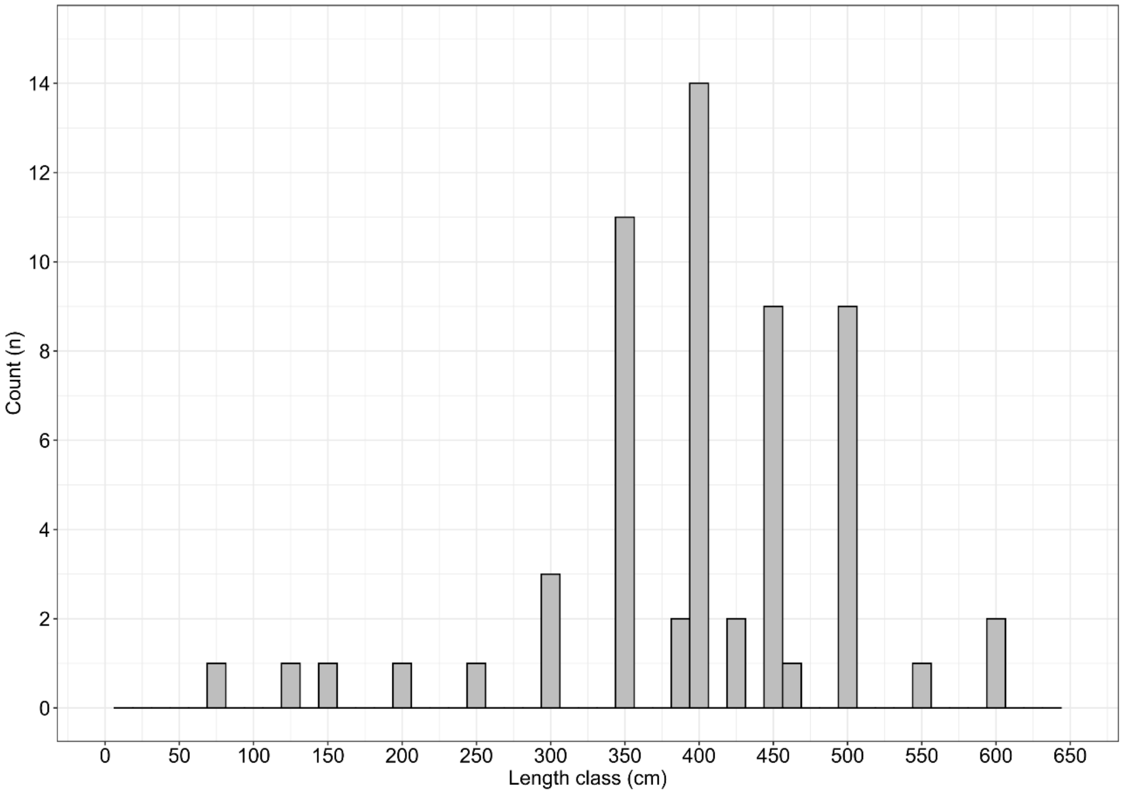

Figure 24.2. Greenland shark (*Somniosus microcephalus*) in the Northeast Atlantic. Length distribution of Greenland shark captured during the annual German Greenland Groundfish Survey (1981–2020; n = 72; length measurements available for n = 60 specimens).

25 Catsharks (*Scyliorhinidae*) in the Northeast Atlantic

25.1 Stock distribution

This section addresses four species of catsharks that occur on the continental shelf and upper slope of the ICES area: lesser-spotted dogfish (or small-spotted catshark) *Scyliorhinus canicula*, greater-spotted dogfish *Scyliorhinus stellaris*, black-mouth dogfish (or black-mouth catshark) *Galeus melastomus* and Atlantic catshark *Galeus atlanticus.* Other catsharks that occur in deeper waters (*Apristurus* spp. and *Galeus murinus*) are not included here (see Section 5). All catsharks are demersal and oviparous (egg-laying) species.

These species have been referred to as catsharks, dogfishes and other names including hounds. Names recognised by FAO may not be suitable to minimise confusions with *Scyliorhinus canicula* being referred to as small-spotted catshark and *S. stellaris* as nursehound. Therefore, ICES refer to these species as follows:

English name	Scientific name
Lesser-spotted dogfish	*Scyliorhinus canicula*
Greater-spotted dogfish	*Scyliorhinus stellaris*
Black-mouth dogfish	*Galeus melastomus*
Atlantic catshark	*Galeus atlanticus*

Lesser-spotted dogfish: *S. canicula* is an abundant species occurring on a range of substrates (from mud to rock) on the European continental shelves, from coastal waters to the upper continental slope, but is most abundant on the shelf. Its distribution ranges from Norway and the British Isles to the Mediterranean Sea and Northwest Africa (Ebert and Stehmann, 2013). ICES currently consider 4 stock units for this species: (i) North Sea ecoregion (Subarea 4 and divisions 3.a and 7.d), (ii) Celtic Seas and west of Scotland (Subarea 6 and divisions 7.a–c and 7.e–j), (iii) northern Bay of Biscay (divisions 8.a–b and 8.d), and (iv) Atlantic Iberian waters (divisions 8.c and 9.a).

See stock annexes for information about *S. canicula* in northern Bay of Biscay (divisions 8.a–b and 8.d) and in the Cantabrian Sea and Atlantic Iberian waters (divisions 8.c and 9.a).

Greater-spotted dogfish: *S. stellaris* is a locally frequent inshore shark of the Northeast Atlantic continental shelf and is generally found from shallow water to depths of about 125 m on rough or rocky bottoms, including areas with algal cover (e.g. kelp forests) (Ebert and Stehmann, 2013). It is Europe's largest catshark, growing to at least 130 cm.

This species is currently only assessed for the subareas 6 and 7, as it is locally common in parts of this area, and data are limited for other parts of the species' biogeographic range, where it occurs at lesser density.

See stock annex for information about *S. stellaris* in subareas 6 and 7.

Black-mouth dogfish*:* *G. melastomus* is a small-sized shark (<90 cm), found on the upper slope in the Mediterranean Sea and the Atlantic from northern Norway and the Faroe Islands to Senegal (Ebert and Stehmann, 2013).

This species is currently assessed over two management units (i) Celtic Seas and west of Scotland (Subarea 6 and divisions 7.a–c and 7.e–j), and (ii) Bay of Biscay and Atlantic Iberian waters (Subarea 8 and Division 9.a).

See stock annex for information about *Galeus melastomus* in Atlantic Iberian waters (Subarea 8 and Division 9.a).

Atlantic catshark: *G. atlanticus* is a small catshark found on the continental slopes living in depths of 330–790 m. Its distribution in the Eastern Atlantic ranges from North of Spain to Portugal into the Mediterranean and further south to Morocco and possibly to Mauritania. Northern range limits are unknown (Ebert and Stehmann, 2013), as there is confusion between this species and *G. melastomus* (see Rey *et al.*, 2006 for distinguishing characters). The stock status of *G. atlanticus* is not assessed.

25.2 The fishery

25.2.1 History of the fishery

Catsharks are a bycatch of demersal trawl, gillnet and longline fisheries over much of the ICES area. They are usually of low commercial value and, with the exception of some seasonal, small-scale fisheries in some coastal areas, are not subject to target fisheries.

The retention patterns of catsharks in the North Sea and Celtic Seas ecoregions are highly variable, with varying proportions retained/discarded (Silva and Ellis, 2019). Larger individuals are landed for human consumption (more so in the southern parts of the ICES area). They are also landed in some areas as bait for pot fisheries, especially in fisheries for whelk *Buccinum undatum* or brown crab *Cancer pagurus* around the British Isles.

25.2.2 The fishery in 2020

Although so far unquantified, COVID-19 is expected to have affected fishing activity in 2020, with national or local restrictions on fishing activity reducing fishing effort for at least part of the year.

25.2.3 ICES Advice applicable

Before 2012, ICES advice on catsharks was included in the regional demersal elasmobranch advice. Species-specific advices for catsharks have been given since 2012.

The last assessments of catsharks were carried out in 2019 valid for 2020 and 2021 and were based on the ICES approach to data-limited stocks. New assessments were conducted in 2021 valid for 2022 and 2023. The table below presents a summary of the assessments since 2017.

STOCK	STOCK CODE	ASSESSMENT CATEGORY	ADVICE BASIS	ADVISED LANDINGS (2018–2019)	ADVISED LANDINGS (2020–2021)
Lesser-spotted dogfish (*Scyliorhinus canicula*) in Subarea 4 and divisions 3.a and 7.d	syc.27.3a47d	3	Precautionary	3380 tonnes	2380 tonnes
Lesser-spotted dogfish (*Scyliorhinus canicula*) in Subarea 6 and divisions 7.a-c and 7.e–j	syc.27.67a-ce-j	3	Precautionary	4296 tonnes	3540 tonnes
Lesser-spotted dogfish (*Scyliorhinus canicula*) in divisions 8.a-b and 8.d	syc.27.8abd	3	Precautionary	Catches should be no more than 5592 tonnes in each of the years 2018 and 2019. If discard rates do not change from the average of the last three years (2014–2016), this implies landings of no more than 611 tonnes.	ICES has not been requested to provide advice on fishing opportunities for this stock.
Lesser-spotted dogfish (*Scyliorhinus canicula*) in divisions 8.c and 9.a	syc.27.8c9a	3	Precautionary	1178 tonnes	ICES has not been requested to provide advice on fishing opportunities for this stock.
Greater-spotted dogfish (*Scyliorhinus stellaris*) in subareas 6 and 7	syt.27.67	3	Precautionary	Decrease by 36% compared to the average of 2014–2016.	Decreased by 20% compared to the average of 2016-2018.
Black-mouth dogfish (*Galeus melastomus*) in subareas 6 and 7 (West of Scotland, southern Celtic Seas, and English Channel)	sho.27.67	3	Precautionary	Could be increased by no more than 20% compared to the average catches in 2014–2016.	ICES has not been requested to provide advice on fishing opportunities for this stock.
Black-mouth dogfish (*Galeus melastomus*) in Subarea 8 and Division 9.a	sho.27.89a	3	Precautionary	156 tonnes	ICES has not been requested to provide advice on fishing opportunities for this stock.

25.2.4 Management applicable

These species are not subject to species-specific fisheries management measures in EU waters.

Galeus melastomus was originally included in the list of deep-water sharks, but Council Regulation (EC) 1182/2013 removed this species from this list following ICES advice. This review was based on the fact that its main distribution extended to upper slope and outer shelf habitats, which are not considered deep-water habitats, and that it had different life-history traits from other species on the list (with the assumption of lower vulnerability towards fishing pressure). No management has been applied for this species since.

25.3 Catch data

25.3.1 Landings

Landings of catsharks were traditionally reported in category groups (e.g. dogfishes and hounds) in some countries, though in recent years more species-specific landings have become available. The lack of historical landings data and the uncertainty associated with recent species-specific information suggest data herein should be viewed with caution.

Nevertheless, in areas where S*cyliorhinus canicula* is much more abundant than *S. stellaris*, reported landings may be regarded as representative of the former species. The species is of minor interest to small-scale fisheries and local markets and most landings have been sold through fish auction markets.

Landings data for the period 2005–2015 were revised in 2016, following the WKSHARK2 workshop (ICES, 2016) and the dedicated data call where the 10-year time-series was requested. In 2017, the data call for WGEF requested an update of 2015 and report of 2016 landings. The ICES estimates of data presented (tables 25.1a–f) are based upon an analysis of landings data since 2005 reported in the 2016 and subsequent data calls. Some reported data were corrected, allocation to stocks were consolidated based on expert knowledge.

i. Some landings of catsharks have previously been reported in generic ′dogfish′ categories, this fraction of the landings is reducing in recent years to a few percent since 2016;
ii. Some landings reported as either *S. canicula* or *S. stellaris* may comprise a fraction of the other species. For example, Portuguese landings from 9.a assigned to *S. stellaris* are likely to correspond to *S. canicula* only;
iii. It is unclear as to whether catsharks used for pot bait are reported in landings data.

The confusion between *S. canicula* and *S. stellaris* is likely to have a greater impact on the lesser abundant *S. stellaris*.

Nominal landings data for *S. canicula* (including possible mixing with *S. stellaris*) from Subarea 4 and divisions 3.a and 7.d (Table 25.1a), subareas 6 and 7 (Table 25.1a), divisions 8.a–b and 8.d (Table 25.1.c) are reported mainly from France and Spain, while those from divisions 8.c and 9.a are reported by Spain and Portugal (Table 25.1d).

Nominal landings data for *G. melastomus* from subareas 6 and 7 (Celtic Seas) have only been declared by France and Spain (Table 25.1e) and amount to zero in the last two years. There are no reported landings prior to 2002. It is likely that this species was caught in deep-water fisheries prior to these years, but was discarded or reported under generic landing categories.

Landings data for *G. melastomus* from Subarea 8 are reported mainly by Spain, whereas most landings from Division 9.a are from both the Portuguese and the Spanish fleets (Table 25.1f). In

2010, reported landings declined due to the introduction of the zero-TAC for deep-water sharks (where this species was previously included). Following the removal of this species from the list of deep-water sharks in 2013, international landings increased to reach their highest value in 2018 (181 tonnes).

Given the widespread discarding of catsharks, reported landings are not considered representative of catch.

25.3.2 Discards

Scyliorhinus canicula and other catsharks are often discarded from continental shelf fisheries (e.g. Silva and Ellis, 2019). The potentially high discard survival of species in the Scyliorhinidae family, at least for continental shelf fisheries, means that landing data are likely to be more representative of dead removals.

In 2017, several aspects of the discards were investigated in WKSHARK3, however overall estimates of discards were not achieved (ICES, 2017b).

Discard data for *G. melastomus* and *S. canicula* from the Iberian and Celtic Sea are available from Spanish on board observations. The Spanish discard sampling carried out in application of the EU-DCF (Data Collection Framework) consists of at-sea a simple random sampling (SRS) program design with recording of refusals (Santos *et al*., 2010 WD).

Discard information of *S. canicula* and *G. melastomus* is also available from several countries in Subarea 8 and Division 9.a (Table 25.2a and 25.2b). For *S. canicula,* discard estimates in the period 2009–2016 ranged from 33–195% of the total landed weight, with trawlers being the main fleet considered. Discards of *G. melastomus* in Subarea 8 and Division 9.a have been higher than reported landings throughout the time-series. However, these preliminary estimates may be an artefact of raising factors applied to the subsampling of commercial catches.

In the Portuguese crustacean bottom otter trawl fishery operating in Division 9.a, the most frequently discarded demersal elasmobranchs were *G. melastomus* and *S. canicula*. Discard information (sampling effort, species frequencies of occurrence and discard estimates) was compiled for this fleet and the two species for the period 2016-2020 by Fernandes (WD11 - 2021). In 2020, the Portuguese onboard sampling programme was compromised by the pandemic situation due to Covid-19 and the sampling only occurred in the first quarter of the year. For this reason, the sampling effort was not representative of the fishing effort of the bottom otter trawl fleet (OTB) and new discard estimation procedures were applied for the two species: discards of 54 t were obtained for *G. melastomus* in OTB_CRU fishery based on the last 3-year estimates (2017-2019); due to an irregular frequency of occurrence pattern in discards a new preliminary approach using standardized DPUE series was developed for *S. canicula* (WD11 – Fernandes, 2021). Discard estimates for the artisanal fleet are not available, but proportions of discards by métier in sampled trips are presented in Table 25.3. *Scyliorhinus canicula* and *G. melastomus* are among the most discarded species by commercial fishing vessels with a fishing permit to set gillnets or trammel nets (LOA >= 12 m) (Figueiredo *et al*., 2017 WD). Frequency of occurrence (%) of both species in the discards from hauls with gillnets and/or trammel nets from those vessels range between 31 and 57% for *S. canicula* and between 0 and 6% for *G. melastomus* (Figueiredo *et al.*, 2017 WD). For further details regarding estimated total discarded weight, length distribution and sex ratio for both species please refer to ICES (2014), Prista and Fernandes (2013 WD), Figueiredo *et al.* (2017 WD) and Fernandes (WD11 – 2021).

Discards in French fisheries from 2011 to 2016 have been estimated for stocks syc.27.347d, syc.27.8abd, syc.27.7a-ce-j, syt.27.67, sho.27.67, sho.27.89a (and presented at WKSHARK3) using two methods: i) standard method for raising discards to the landings of the species and ii) method where observed discards are raised to the total landings of all species combined (ICES, 2017a). *S. canicula* is a bycatch in most French fisheries and a high number of DCF level 6 métiers catch it. For métiers which do not land the species (100% discards) discards were estimated by raising to the total landings (all commercial species of fish, molluscs and crustaceans combined). An overall discarding rate (discards/landings) was calculated to 170%. This rate varied from 10–100% across métiers. French discards data from 2011-2020 where available.

Discards from Irish vessels of syc.27.7a-ce-j are provided annually.

25.3.3 Discard survival

S. canicula have been shown to have a high discard survival in beam and otter trawl fisheries (Revill *et al*., 2005; Rodriguez-Cabello *et al.*, 2005; Barragán-Mendez *et al.*, 2020), and anecdotal observations suggest that it would also have high survival in coastal longline fisheries. A review of survival studies on this species and other sharks can be found in Ellis *et al*., (2016). There are no data for discard survival of these species in gillnet fisheries. There are also no data for the survival of *G. melastomus* caught in fisheries operating along the outer continental shelf and upper slope. A study of survival of deep-water sharks caught by longline indicated some survivorship for this species using this fishing gear (Rodríguez-Cabello and Sanchez, 2017).

25.3.4 Quality of catch data

Accurate species-specific landings data are not currently available. The ongoing (since 2012) French programme "Elasmobranches On Shore" aims to better evaluate the relative proportion of species mixed under a single landing name, as it is for *S. canicula* and *S. stellaris* (Mayot *et al.*, 2021). This programme will enable to correct a large part of the French Landings Data. To date, the results have been only partially communicated. In the past, only *S. canicula* was used for catsharks landing but labelling has been improving in recent years in France with the progressive appearance of the landing name *S. stellaris* in fish markets.

25.4 Commercial catch composition

Data from national observer programmes have provided information on the size distribution of the retained proportions of the catch. Generally, only larger individuals (L_T larger than 45 cm) are retained (Silva and Ellis, 2021. However, retention of *S. canicula* and *S. stellaris* may depend locally more on market demand rather than size as these species can be often landed as bait for pot fisheries (Silva and Ellis, 2021).

The length distributions for *S. canicula* from France (divisions 7.a-c.e.k, for stocks syc.27.3a47d and syc.27.8abd; 2011–2015) and Spain (OTB Basque fleet for stock syc.27.8abd; 2011–2015) were shown in ICES (2017a). Length-distributions of *S. canicula* from the Basque country trawl fleet are shown on Figure 25.1a. Catch length ranges from 10 cm to 73 cm. However, the proportion retained is from 40 cm to 73 cm, while fish of lengths from 10 cm to 50 cm are mostly discarded. Length distributions of *S. canicula* landed from the Spanish trawl fleet in ICES division 8.c and 9.a for the period 2015–2019 is shown on Figure 25.1b. Catch length for stock syc.27.8c9a by Spanish trawl fleet, ranges from 10 cm to 70 cm but the proportion retained is from 40 cm to 65 cm.

S. canicula caught by the Dutch beam trawl fleet included some smaller fish (35–40 cm L_T) in 2014 than in previous years (Figure 25.2), but most sampled fish were in the 50–65 cm L_T size categories.

Length frequency distributions of *S. canicula* in Portuguese landings are provided annually for the trawl and polyvalent fleets. Data from 2017–2020 was updated. Length-distributions of

S. canicula from the Portuguese trawl and artisanal fleets (2009–2020) were similar for both nets and trawlers, and between years (ICES, 2016; Moura *et al*., 2017a; Figure 25.3a). Length-frequency distributions of *S. canicula* retained and discarded in fishing trips using set nets, between 2011 and 2014 (n = 49) are presented in Figure 25.3b (Figueiredo *et al.*, 2017). A DCF pilot study on trammel nets (GTR_DEF_>=100_0_0; 2012–2014) showed no major differences in the length frequencies of *S. canicula* between sexes or between years (Moura *et al.*, 2015b WD). Length frequency distributions of *G. melastomus* in Portuguese discards are provided annually for the trawl fleet (OTB_CRU) (Figure 25.3c).

The length-range for *S. stellaris* caught by the French fleet in 2012–2014 was 44–124 cm (ICES, 2014).

25.5 Commercial catch–effort data

Commercial catch and effort data have not been analysed for most scyliorhinid stocks in the ICES area.

Landings per unit of effort data from the Basque Country OTB fleet (divisions 8.abd; Figure 25.4) showed an increasing trend over the period 2001–2018.

25.6 Fishery-independent information

Groundfish surveys provide valuable information on the spatial and temporal patterns in the species composition, size composition, sex ratio and relative abundance of catsharks. It is noted that these surveys were not designed primarily to inform on these populations, and so the gears used, timing of the surveys and distribution of sampling stations may not be optimal. However, these surveys provide the longest time-series of species-specific information.

Depending on the area and species, one to several surveys provide reliable time-series of data (see table below).

ICES stock code	Survey used for assessment
syc.27.3a47d	IBTS-Q1 and Q3, BTS-Eng-Q3, CGFS-Q4, and BTS-BE-Q3 (included since 2021).
syc.27.67a-ce-j	EVHOE-WIBTS-Q4, IGFS-WIBTS-Q4, Spanish Porcupine Bank survey SP-PORC-WIBTS-Q3, and UK (E&W)-BTS-Q3 (2005-2020).
syc.27.8abd	EVHOE-WIBTS-Q4
syc.27.8c9a	Spanish surveys in the South (Gulf of Cadiz) SpGFS-GC-WIBTS-Q1-Q4 (ARSA) and in the North of Spain (SpNGFS-WIBTS-Q4) and Portuguese survey (PtGFS-WIBTS-Q4)
syt.27.67	UK (E&W)-BTS-Q3 and CGFS-Q4 (included since 2021)
sho.27.67	Spanish Porcupine Bank survey SP-PORC-WIBTS-Q3
sho.27.89a	EVHOE-WIBTS-Q4 survey in Subarea 8, Spanish IBTS-CG-Q1-Q4 (ARSA) and the Portuguese Crustacean Surveys/*Nephrops* TV Surveys (PT-CTS UWTV (FU 28-29)).

For syc.27.3a47d, previous assessments of the biomass trend were based on the time-series of four surveys. (IBTS-Q1 and Q3, BTS-Eng-Q3 and, CGFS-Q4). Following WKSKATE (ICES, 2021) recommendation to explore and evaluate spatial coverage, catch rates and size distribution, of category 3 stocks the Belgian Beam trawl survey in quarter 3 (BTS-BEL-Q3) was investigated.

This North Sea survey is organized yearly at the end of August and beginning of September since 1992 on-board of the *RV* Belgica and covers an important area in the south-western part of the North Sea (i.e. Greater Thames estuary and the Wash), covering a significant part of the distribution area of *S. canicula* in divisions 4.c and 4.b. Over the entire time series *S. canicula* was the most abundant elasmobranch species across the entire survey area and was captured over a wide length range (10–67 cm L_T) consistently. Catches consisted predominantly of individuals <40 cm L_T, however, in recent periods there has been an increase in larger individuals >50 cm L_T being caught.

To conclude, the BTS-BEL-Q3 met the agreed criteria of representativeness of survey stock abundance defined by WKSKATE (ICES, 2021) and is decided to be included in the syc.27.3a47d survey trend assessment. Currently only 2010–2020 BTS-BEL-Q3 survey data have been uploaded to DATRAS. Historical data (prior to 2010) are being prepared for uploading to DATRAS and data since 2004 were available to be extracted from the national database. In this context, catch rates (n. h^{-1} and n. $km^{-2)}$ for the period 2004–2020 are available for this survey, truncating the combined survey index from 1993 to 2004.

<u>For syc.27.67a-ce-j,</u> earlier analyses of the Scottish surveys in Division 6.a suggested increasing catch rates (see ICES, 2010), but updated analyses are required. Despite survey catch trends in the UK-Q1SWBeam (Q1SWECOS) in 7.e not being used for assessment, *S. canicula* is the most frequently caught elasmobranch across the survey area, over a wide length range (8–75 cm L_T). This species is most abundant in the outer parts of Lyme Bay, Eddystone grounds and parts of the Normano-Breton Gulf and at the southern entrance to St George's Channel (Silva *et al.*, 2020 WD; Silva and Ellis, 2021 WD). Updated biomass index from Spanish Porcupine survey (SpPGFS–WIBTS–Q4) is presented in 2021 WD03 (Fernández-Zapico *et al.*, 2021a).

Previously, the Basque ITSASTEKA survey reported two demersal sharks, *G. melastomus* and *S. canicula*, the latter was the second most abundant species in the survey and often encountered in all trawl stations except areas of shallower waters where they were less abundant (depths <250 m) (ICES, 2014). This survey ceased in 2014 and is therefore no longer used for assessment (for further information, see ICES, 2014).

<u>For syt.27.67,</u> it is noteworthy that *S. stellaris* has a more restricted distribution than *S. canicula*, preferring rocky and inshore habitats. Hence, most surveys do not sample their main habitats effectively, resulting in low catch rates, especially the smallest size groups. The catchability of larger individuals may also be low in some survey trawls. The UK (E&W)-BTS-Q3 is one of the few surveys to encounter this species regularly, especially around Anglesey and Lleyn Peninsula and in Cardigan Bay.

<u>For syc.27.8c9a</u>, three surveys provide reliable time series of abundance or biomass index which are used in the assessment of this stock. These are the Spanish bottom trawl survey carried out in the north of Spain waters (Galician and Cantabrian Sea shelf) (Fernández-Zapico *et al.*, 2020 WD; WD 10 - Fernández-Zapico *et al.*, 2021b) and in the south of Spain (Gulf of Cádiz) which is carried out in two seasons in Spring (Q1) and Autumn (Q4). The Portuguese survey (PtGFS-WIBTS-Q4) also included covers all the central area of Division 9.a.

In 2019, both PtGFS-WIBTS-Q4 and PT-CTS UWTV (FU 28–29) were not conducted due to legal issues. In 2020, the PT-CTS UWTV (FU 28–29) was still not conducted, due to the same issues and the PtGFS-WIBTS-Q4 survey was only partly (6% of hauls) carried out because of the combination legal/logistic constraints and the COVID-19 pandemic.. The effect of the Portuguese surveys in the stock indicators for lesser-spotted dogfish and black-mouthed dogfish was evaluated and discussed during the WGEF (WD05 - Moura *et al.*, 2021). The lack of data in 2019 and 2020 for these surveys appeared to have only minor effect on the stock size indicators.

<u>Other surveys</u>: Whilst *S. stellaris* is caught only occasionally in the North Sea ecoregion, it is captured regularly in the eastern Channel (Division 7.d). It is taken in small numbers during the UK (E&W)-BTS-Q3 in 7.d and the French CGFS-Q4. Whilst data for the former are too limited to inform on trends in relative abundance, this species is observed in most years (Ellis, 2015 WD).

The Spanish SpN-GFS-WIBTS-Q4 survey catches *G. melastomus.* However, data are only shown as general trends and not used for assessment since most of the biomass (nearly the 75%) is caught in the additional deeper hauls (depths over 500 m) that are not standardized (Fernández-Zapico *et al.*, 2021b). In 2021, the biomass of *G. melastomus* in standard hauls in Division 8.c during last two years was higher than in the previous five years reaching the highest value of biomass in the historical series. In additional deeper hauls, biomass of *G. melastomus* increased in 9.a Division compared to the previous year but decreased slightly in 8.c Division (WD 04 - Fernández-Zapico *et al.*, 2021b) (Figure 25.11a). There seems to be no clear pattern to their geographical distribution. The length-distribution of *G. melastomus* ranges from 14–71 cm over standard stratification (70–500 m) (Ruiz-Pico *et al*., 2017 WD). In 2020, the length distribution of *G. melastomus* showed more abundance of specimens between 15 and 50 cm than in previous years in 8.c Division. In additional deeper hauls, most of the specimens were adults, from 36 to 74 cm in 9.a, with a mode around 47 cm, and from 30 to 69 cm in 8.c, with a mode around 45 cm (WD 04 - Fernández-Zapico *et al.*, 2021b).

Catsharks occur out of the range of assessment stock units. *S. stellaris* is a coastal species that is caught only occasionally in surveys in the Biscay and Iberian ecoregions. *G. melastomus* is caught in the northern North Sea (Division 4.a) and Norwegian Deep, but most IBTS-Q1 and Q3 survey stations are <200 m deep, and so catch rates may not be informative of stock size.

25.7 Life-history information

There is no recent information available for life-history parameters in the study area. However some new studies have been published regarding social behaviour, sexual dimorphism or population genomics (Barragán-Méndez, *et al.*, 2020; Manuzzi *et al.*, 2019). Summaries of knowledge on life history of the various species are provided in the corresponding stock annexes.

Catsharks can have protracted spawning periods, with *S. canicula* bearing egg cases observed for much of the year. This protracted egg-laying season may result in no apparent cohorts in length distributions. Age and growth parameters are uncertain for all the species considered here.

The reproductive biology of *S. canicula* has been studied in different regions by different authors. According to Ellis and Shackley (1997), males in the Bristol Channel mature at lengths of 49–54 cm ($L_{50\%}$ at 52 cm) and females at 52–64 cm ($L_{50\%}$ at 55 cm). The egg-laying season lasts at least ten months with a peak in June and July, and fecundity increases with fish length. Egg cases are often laid on erect, sessile invertebrates (e.g. bryozoans, poriferans and hydroids). Although, data for *S. stellaris* in the Atlantic may be lacking, studies in the Mediterranean suggested that for both sexes length-at-maturity ranges from 76–79 cm (Capapé, 1977).

The reproductive biology of *G. melastomus* was studied from specimens collected off the Portuguese southern slope by Costa *et al.* (2005). Sex ratio from specimens caught by commercial crustacean trawlers was 1:1. This species is sexually dimorphic with males approaching maturity at smaller sizes than females ($L_{50\%}$ males = 49.4 cm; $L_{50\%}$ females = 69.7 cm). Mating and egg deposition were found to take place all year round, with peaks of reproductive activity in winter and in summer.

A large nursery ground for *G. melatomus* was found in an Irish offshore Special Area of Conservation in 2018 (Marine Institute, 2019).

25.8 Exploratory assessment models

ICES (2014) report GAM analyses of survey trends for *S. canicula* in the CGFS-Q4, UK (E&W)-BTS-Q3 in 7d, IBTS-Q1 and IBTS-Q3 surveys.

Biomass indices of *S. canicula* for Portuguese waters (Division 9.a) were standardized using the catch rates by haul from the Portuguese groundfish survey PtGFS-WIBTS-Q4. In the standardization process of CPUE, a generalized linear mixed model (GLMM) with Tweedie distributed errors was applied. CPUE index time-series was estimated based on the relationship between CPUE and available predictive factor variables, selected depending on their significance after model adjustment. In the tested models, the logarithm of catch rate of the species in each haul (kg h^{-1}) was the response variable used. Apart from factor year, the final model included the variables depth stratum (intervals of 100 meters) and fishing sector, the latter as the random variable. More details on the methodology used are presented in Figueiredo and Serra-Pereira (2012 WD) and Moura *et al.* (2015b WD).

Biomass indices of *G. melastomus* for Portuguese waters (Division 9.a) were standardized using catch rates by haul during the Portuguese Crustacean Surveys/*Nephrops* TV Surveys (PT-CTS (UWTV (FU 28–29))). Data were restricted to depths >500 m. In the standardization process of CPUE, a generalized linear model (GLM) was applied. In the tested models, the logarithm of catch rate of the species in each haul (kg h^{-1}) was the response variable. The final model included the variables year and fishing sector, and followed a Gaussian distribution (Moura *et al.*, 2015a WD).

25.9 Stock assessment

25.9.1 Approach

Scyliorhinidae stocks were assessed in 2021 using survey trends. Indices of the total biomass were used for all stocks except greater-spotted dogfish in subareas 6 and 7 where exploited biomass indices were used. These stocks are ICES category 3 using the ratio of the (possibly combined) survey index in the two last years to the previous five years. Survey data used are described above (see Section 25.6).

25.9.2 Lesser-spotted dogfish (*S. canicula*) in Subarea 4, and divisions 3.a and 7.d (North Sea, Skagerrak and Kattegat, Eastern English Channel)

Survey indices in 2021 have been updated following WKSKATE methodology with these based on DATRAS exchange data (ICES, 2021). For further details please refer to Section 15 (North Sea Demersal skates and rays) of this report. Survey indices show diverging trends. The combined index from the two NS-IBTS surveys (Q1 and Q3) showed a 14% decrease. The index of the BTS-Eng-Q3 shows a lesser decrease of 5%, while the CGFS-Q4 index gives a contrasting signal with a 32% increase. Note that for this later survey, the 2020 sampling was restricted to French waters (i.e. ICES rectangles 29F1 and 30E9 were not sampled) and therefore the value derived for 2020 was deemed not representative. Following the ICES missing data approach, the 2020 CGFS-Q4 data were excluded from the derivation of the index ratio. The newly included BTS-BE-Q3 survey index shows a minor decrease (-1%). The combined index (Figure 25.5a) showed that catch rates for 2019–2020 were stable (+0.4%) compared to the five preceding years (2014–2018). In addition, the precautionary buffer was not applied (last applied in 2019).

25.9.3 Lesser-spotted dogfish (*S. canicula*) in Subarea 6 and divisions 7.a–c and 7.e–j (Celtic Seas and West of Scotland)

The results of 2021 analyses indicated an overall stability of the stock size indicator (Figure 25.6a). This is based on the combination of standardised survey indices from four surveys IGFS-WIBTS-Q4, Spanish Porcupine Bank survey SP-PORC-WIBTS-Q3, UK-(E&W)-BTS-Q3, EVHOE-WIBTS-Q4. Surveys IGFS-WIBTS-Q4, SP-PORC-WIBTS-Q3 and UK(E&W)-BTS-Q3 showed around 20% decrease in its index (Figure 25.6a). The index based on the EVHOE-WIBTS-Q4 survey shows the higher rate of change, with an increase of 16% (Figure 25.6a). Therefore, the combined index (Figure 25.6a) showed an overall stability, with catch rates for 2019–2020 being 2% higher than the five preceding years (2014–2018). It should be noted that the combined index did not include UK(E&W)-BTS-Q3 data from 2020, results are considered to be misleading since these data only relate to the fished area in 7.f, with remaining survey area (7.a.g) missed due to COVID-19 pandemic (Silva and Ellis, 2021 WD10).

25.9.4 Lesser-spotted dogfish (*S. canicula*) in divisions 8.a–b and 8.d (Bay of Biscay)

The results of 2021 analyses indicated that survey indices in the EVHOE-WIBTS-Q4 survey (Figure 25.7) for the last two years (2019–2020) were 14.6% higher than the five preceding years (2014–2018, no data was available for year 2017). After a decrease in 2018, the survey index has increased reaching almost the highest values of the time series (2009–2011).

25.9.5 Lesser-spotted dogfish (*S. canicula*) in divisions 8.c and 9.a (Atlantic Iberian waters)

The results of 2021 analyses indicated that there was an overall sustained increase in the biomass indices (Figure 25.8a). The combined index is based on standardised survey indices from four surveys; Sp-GC-WIBTS-Q1 and Q4 (average of spring and summer Spanish surveys in the Gulf of Cádiz), Portuguese survey (PtGFS-WIBTS-Q4, no data in 2019–2020) and Sp-N-WIBTS-Q4 (North Spanish Shelf bottom survey). The combined survey index (Figure 25.8b) showed that catch rates for 2019–2020 were 12% higher than the five preceding years (2014–2018). ICES has not been requested to provide advice on this stock.

25.9.6 Greater-spotted dogfish (*S. stellaris*) in subareas 6 and 7 (Celtic Seas and West of Scotland)

The results of 2021 analyses are that the biomass index in 2019 was 2% higher than the average index during the five preceding years (2014–2018, Figure 25.9). The index calculation was changed, following methods from WKSKATE (ICES, 2021) two indices of exploitable biomass (individuals ≥50 cm TL) were used instead of one single index of total abundance (number/hour). The standardized survey index was calculated from the UK(E&W)–BTS–Q3 index in $kg.h^{-1}$ and the CGFS-Q4 index in $kg.km^{-2}$. The latter have been used for the first time whilst previous assessments were based on UK(E&W)–BTS–Q3 only. The standardized index is the average of the two indices standardized to their long-term mean for years 1997–2019.

The small increase of the index cannot be considered as a significant short-term (between the 2 last and the previous 5 years) increase, however the index suggests a longer-term increase over the entire time-series (Figure 25.9). Reported landings are increasing but this is mainly explained by the labelling improvement for *Scyliorhinus stellaris* in auctions. Therefore, landings data were not used in the assessment.

Data from 2020 were not included because UK(E&W)-BTS-Q3 covered only Division 7.f, so that the main part of the stock area, Cardigan Bay and Anglesey in 7.a, was not sampled due to COVID-19 (Silva and Ellis, 2021 WD10) and CGFS Q4 only covered the French part of 7.d. As a consequence, the assessment is based on the comparison of the combined index in 2019 to the average of the index in 2014–2018.

25.9.7 Black-mouth dogfish (*Galeus melastomus*) in subareas 6 and 7 (Celtic Sea and West of Scotland)

The stock size indicator in kg.hr^{-1} for 2019–2020 was 34% lower than the five preceding years (2014–2018) (Table 25.4 and Figure 25.10a). The biomass index was calculated only from SP-PORC-WIBTS-Q3 survey. Uncertainty on data did not allow to use landings.

25.9.8 Black-mouth dogfish (*Galeus melastomus*) in Subarea 8 and Division 9.a (Bay of Biscay and Atlantic Iberian waters)

The combined survey index is based on survey indices of total biomass in kg.km^{-2} from Sp-GC-WIBTS-Q1 and Q4 (average of spring and Autumn Spanish surveys in the Gulf of Cádiz), PT-CTS UWTV (FU 28–29) (not data in 2019–2020) and EVHOE-IBTS-Q4 standardized to the mean of each series then averaged per year (Figure 25.11b). Results from the analyses showed that catch rates for 2019–2020 were 125% higher than the five preceding years (2014–2018). This is related to the strong increases observed in EVHOE-IBTS-Q4 since 2018 and the lack of data on this last survey in 2017. The value reported for PT-CTS UWTV (FU 28–29) in 2018 is consistent with this increase (highest estimate of the time series in the latest years) but the survey was not conducted in 2019 and 2020. The ARSA survey showed no major trends in the abundance of *G. melastomus* in the Gulf of Cadiz, with peaks in 2006 and 2013.

25.10 Quality of the assessments

Although the trawl surveys used in this report were not designed to sample catsharks, *S. canicula* and *G. melastomus* are sampled in large numbers in various surveys. Survey indices are considered to properly track stock abundance trends for these species.

In relation to *G. melastomus*, fisheries-independent data in the Portuguese surveys suggest that this species may have been historically aggregated with *G. atlanticus*, and there may be some problems with misidentification of these two species, especially historically (Moura *et al.*, 2015a WD; Moura *et al.*, 2017b WD). Data from the Portuguese crustacean surveys/*Nephrops* TV Surveys (PT-CTS (UWTV (FU 28–29))) conducted in 2014 showed that *G. melastomus* is more abundant and distributed mainly >500 m deep, and so data from depths ≥500 m were considered for assessment purposes.

Survey effort on rocky, inshore grounds is limited, and so catch rates for the larger-bodied *S. stellaris* are low in some surveys, as this species favours rocky, inshore habitats.

Commercial data are more problematic due to the widespread use of generic categories (e.g. “dogfish”), especially in earlier years. Although a greater proportion of the data is reported to species or genus level, the quality of these data has not been evaluated. Other issues may constrain the use of these data, for example possible misidentification in areas such as the Celtic Seas where both *S. canicula* and *S. stellaris* occur. Furthermore, historical data may be underestimated as these species may have not been marketed for human consumption, and might therefore not have all been included in official landings, e.g. in those areas where *S. canicula* may be landed for use as bait in pot fisheries. Therefore, landings data are not considered to be accurate and should be viewed as preliminary results.

Catsharks are mainly caught as bycatch and have a moderate market value (including no human consumption market for the smaller fraction) resulting in a high level of discarding. Previous studies have shown that *S. canicula* may have a high survival rate (see Section 25.3.3), and while there are no current studies for *S. stellaris*, it can be assumed that the survival of this shallow-water species may be high. Therefore, discards of Scyliorhinidae should not be considered exclusively as dead removals. However, for *G. melastomus* anecdotal information suggests survival will be lower. Further studies should be considered if more accurate information on the level of discarding is to be inferred for the two latter species.

Portuguese surveys ((PtGFS-WIBTS-Q4 and PT-CTS UWTV (FU 28–29)) were not conducted in 2019 and in 2020 but the effect in the stock size indicators of syc.27.8c9a and sho.27.89a is thought to be minimal (see Section 25.6; WD05 – Moura *et al.*, 2021).

Although discussions during WKSKATE highlighted the importance of using DATRAS datasets instead of national databases, there are remaining discrepancies in species mapping on historical data within UK(E&W)-BTS-Q3 (in 7.afg) survey series on DATRAS (e.g. *Scyliorhinus stellaris*). Therefore, to make calculations similar across sharks and skate species (with the latter shown in Silva and Ellis, 2020 WD), survey indices presented in 2021 relate to national data (Silva and Ellis, 2021 WD10).

In 2021, EVHOE-WIBTS-Q4 survey indices were updated following WKSKATE methodology using data available on DATRAS (ICES, 2021), contrary to previous advice where calculations were based on national data.

25.11 Reference points

No reference points have been proposed for these stocks.

25.12 Conservation considerations

Both *S. canicula* and *G. melastomus* are listed as Least Concern, and *S. stellaris* and *G. atlanticus* as Near Threatened on the IUCN Red List (IUCN, 2019) and in the Red List of European marine fish (Nieto *et al.*, 2015).

S. canicula, S. stellaris and *G. melastomus* are listed as Least Concern on the Irish Red List of Cartilagenous Fish (Clarke *et al.*, 2016).

25.13 Management considerations

Catsharks are generally viewed as relatively productive in comparison to other elasmobranchs (e.g. McCully Phillips *et al.*, 2015). Given this, and that they are a low value, bycatch species, catsharks are typically of lower management interest in comparison to other elasmobranchs.

Landings data are highly uncertain, and further efforts are required to construct a meaningful time-series. Discarding is known to occur for most of these Scyliorhinidae species and is known to be very high and variable between fleets. Therefore, further efforts are needed to best estimate discard rates.

In recent years, catch rates of *S. canicula* have been increasing in almost all surveys. As one of the more productive demersal elasmobranchs that is often discarded (with a high discard survival) and is known to scavenge on discards, it is unclear as to whether or not the increasing catch rates observed are a sign of a healthy ecosystem.

Discard survival of *Scyliorhinus* spp. is considered to be high, but estimates for discard survival for *Galeus* spp. are currently unavailable.

25.14 References

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Table 25.1a. Catsharks (Scyliorhinidae) in the Northeast Atlantic. Preliminary estimates of landings (t) of lesser-spotted dogfish *Scyliorhinus canicula* in Subarea 4 and divisions 3.a and 7.d (North Sea, Skagerrak and Kattegat, Eastern English Channel). Values prior to 2017 are based on WGEF revised landings. NOTE: These data should be viewed with caution as some countries may have aggregated both *S. canicula* and *S. stellaris* as Scyliorhinidae and the proportion of species-specific may be unknown as both species occur in this area.

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Belgium	238	267	264	337	309	290	311	249	231	325	416	343	338	305	328	256
France	2265	1857	1843	1822	1758	2055	2150	2061	2021	2189	2090	2039	1641	1580	1640	1613
UK	92	121	104	94	118	146	185	181	184	146	185	330	286	275	302	293
Netherlands	56	48	32	29	37	37	47	35	36	45	85	122	141	180	218	186
Total	2652	2293	2243	2282	2222	2528	2693	2526	2472	2705	2776	2834	2406	2340	2488	2448

Table 25.1b. Catsharks (Scyliorhinidae) in the Northeast Atlantic. Preliminary estimates of landings (t) of lesser-spotted dogfish *Scyliorhinus canicula* in the subareas 6 and 7 (Celtic Seas). Values prior to 2017 are based on WGEF revised landings. NOTE: These data should be viewed with caution as some countries may have aggregated both *S. canicula* and *S. stellaris* as Scyliorhinidae and the proportion of species-specific may be unknown as both species occur in this area.

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Belgium	240	225	199	165	168	165	227	236	216	141	252	194	209	181	194	176
Spain	34	33	37	12	17	28	48	109	26	18	20	9	12	25	7	6
France	2936	2873	3101	2728	2479	2368	2359	2060	2284	2292	2024	1919	1677	1518	1479	1277
UK	123	22	115	191	226	111	111	241	380	389	1282	1333	1067	1628	1510	1364
Ireland	92	42	128	248	190	232	317	221	310	336	367	425	524	411	235	224
Netherlands		0			0	6	1	1	4	0	3	1	0		4	2
Total	3426	3195	3579	3344	3080	2909	3064	2868	3219	3176	3948	3881	3489	3763	3429	3048

Table 25.1c. Catsharks (Scyliorhinidae) in the Northeast Atlantic. Preliminary ICES estimates of landings (t) of lesser-spotted dogfish *Scyliorhinus canicula* in divisions 8.a–b and 8.d (Bay of Biscay).

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Belgium	10	13	13	18	24	28	28	32	23	26	27	32	26	25	24	20
Spain	355	338	327	460	445	302	303	472	54	92	130	239	498	370	332	223
France	1229	1247	1352	1382	1117	1085	1000	912	883	720	735	731	671	698	600	459
UK	3						0	2								
Ireland				2												
Total	1597	1598	1691	1863	1586	1415	1330	1418	960	838	892	1002	1195	1093	957	702

Table 25.1d. Catsharks (Scyliorhinidae) in the Northeast Atlantic. Preliminary estimates of landings (t) of lesser-spotted dogfish *Scyliorhinus canicula* in divisions 8.c and 9.a (Atlantic Iberian waters).

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
France	1	1	1	1	0		0	0	0	0	0	0	0	0	0	0
Spain	297	333	327	272	229	336	364	555	577	464	417	398	448	484	449	853
Portugal	568	591	595	546	535	522	551	544	520	521	554	589	619	530	588	555
Total	866	925	923	819	765	858	915	1099	1097	985	971	987	1067	1014	1037	1408

Table 25.1e. Catsharks (Scyliorhinidae) in the Northeast Atlantic. Preliminary estimates of landings (t) black-mouth dogfish *Galeus melastomus* in subareas 6 and 7 (Celtic Seas). Data 2005–2016 revised at WGEF 2017.

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
France	.	.	.				0.1	0	0.4	0.05	0.02	0		0.26	0.13	0.1	0.0	0.2	0.0
Spain	9	1	.	0.1	2.9	0.4							0					0.0	
Total	9	1	0	0.1	2.9	0.4	0.1	0	0.4	0.05	0.02	0	0	0.26	0.13	0.1	0.0	0.2	0.0

Table 25.1f. Catsharks (Scyliorhinidae) in the Northeast Atlantic. Preliminary estimates of landings (t) of black-mouth dogfish *Galeus melastomus* in Subarea 8 and Division 9.a (Bay of Biscay and Atlantic Iberian waters). Data for the period 2005–2016 were revised at WGEF 2017. Data for 2018 were revised in 2021.

		1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Subarea 8	France										1	1	2	2	3	0	0	1	0	1			0	0	0	
	UK																1									
	Spain							4	3	6	36	46	67	74	53	21		8	13	49	47	37	34	36	15	49
	Spain (Basque Country)	4	3	6	2	3	1	1	1	1	*	*	*	*	*	*	*	*	*	*	*	*	*		*	*
	Total	4	3	6	2	3	1	5	4	7	37	47	69	76	56	22	1	9	13	50	47	37	34	34	15	49
Division 9.a	Portugal	17	17	16	20	37	29	35	29	57	37	28	24	12	16	7	2	2	1	21	25	26	34	31	35	42
	Spain										17	22	37	29	22	3		0	2	5	76	104	90	84	50	91
	Total	17	17	16	20	37	29	35	29	57	53	50	61	41	38	10	2	2	3	25	101	130	124	115	84	133
Subarea 8 and Division 9.a combined	Portugal	17	17	16	20	37	29	35	29	57	37	28	24	12	16	7	2	2	1	21	25	26	34	31	35	42
	Spain	0	0	0	0	0	0	4	3	6	53	68	103	103	75	24		8	15	54	123	141	124	119	65	140
	Spain (Basque Country)	4	3	6	2	3	1	1	1	1	*	*	*	*	*	*	*	*	*	*	*	*	*		*	*
	France										1	1	2	2	3	0	0	1	0	1			0	0	0	
	UK																1									
	Total	21	20	22	22	40	30	40	33	64	91	97	130	116	93	32	3	11	16	75	148	167	158	151	100	183

*** Included in Spanish landings.**

Table 25.2a. Catsharks (Scyliorhinidae) in the Northeast Atlantic. Discard estimates (t) of *S. canicula* by country in Subarea 8 and Division 9.a

	S. canicula					
	Spain (9.a, 8.b–c)	Spain (Basque country) (8.a–b, 8.d)	Portugal (9.a)	France (8.a–b, 8.d)	Belgium (8.a–b, 8.d)	TOTAL
2003	1933	348				2281
2004	799	654				1453
2005	397	275				672
2006	1723	173				1896
2007	954	417				1371
2008	300	641				941
2009	954	1092				2046
2010	635	688	30*			1353
2011	721	1054	164*	3342		5281
2012	753	905	N.A.	4835	34	6527
2013	1137	64	N.A.	2497	22	3720
2014	2081	499	140*	4432	192	7204
2015	1864	534	N.A.	8616		11014
2016	1072	389	59*	8821		10341
2017	699		N.A.	6102		6812
2018	686	744	N.A.	5574	52	7056
2019	562	1048	67*	4024	71	5772
2020	109	1197	72*	2450	71	3899

*** denotes estimates from the trawl fleet OTB_CRU only**

Table 25.2b. Catsharks (Scyliorhinidae) in the Northeast Atlantic. Discard estimates (t) of *G. melastomus* by country in Subarea 8 and Division 9.a

	G. melastomus				
	Spain (9.a, 8.b–c)	Spain (Basque country) (8.a–b, 8.d)	Portugal (9.a)	France (8.a–b, 8.d)	TOTAL
2003	589	0			589
2004	244	227			470
2005	527	5			533
2006	553	1			554
2007	1063	N.A.			1063
2008	226	23			249
2009	904	0			904
2010	1272	34			1306
2011	731	7			737
2012	1433	0	36*		1469
2013	749	3	17*		769
2014	1123	9	N.A.		1131
2015		13	35*		48
2016		2	167*		169
2017	251		40*		291
2018	242	0	31*	5	278
2019	465	+	91*		557
2020	128	35	54		217

*** denotes estimates from the trawl fleet OTB_CRU only**

Table 25.3. Catsharks (Scyliorhinidae) in the Northeast Atlantic. Proportion of *S. canicula* and *G. melastomus* discarded by gear from trips sampled under the Portuguese DCF program in Division 9.a.

Year	*G. melastomus*	*G. melastomus*	*S. canicula*
	GNS, GTR	LLS (DWS)	GNS, GTR
2011	0.87 (14)	0.22	0.15
2012	1.00 (14)	0.68	0.16
2013	0.00 (14)	0.28	0.17
2014	1.00 (14)	1.00	0.34

Table 25.4 Black-mouthed dogfish in subareas 6 and 7. Assessment summary, biomass index from the Spanish Porcupine (SP-PORC-WIBTS-Q3) trawl survey (in kg tow^{-1}).

Year	kg tow^{-1}
2001	5.40
2002	7.16
2003	11.33
2004	18.52
2005	22.74
2006	14.59
2007	17.91
2008	19.46
2009	24.31
2010	29.91
2011	26.04
2012	59.03
2013	43.76
2014	51.09
2015	62.88
2016	54.14
2017	38.49
2018	61.35
2019	50.83
2020	30.90

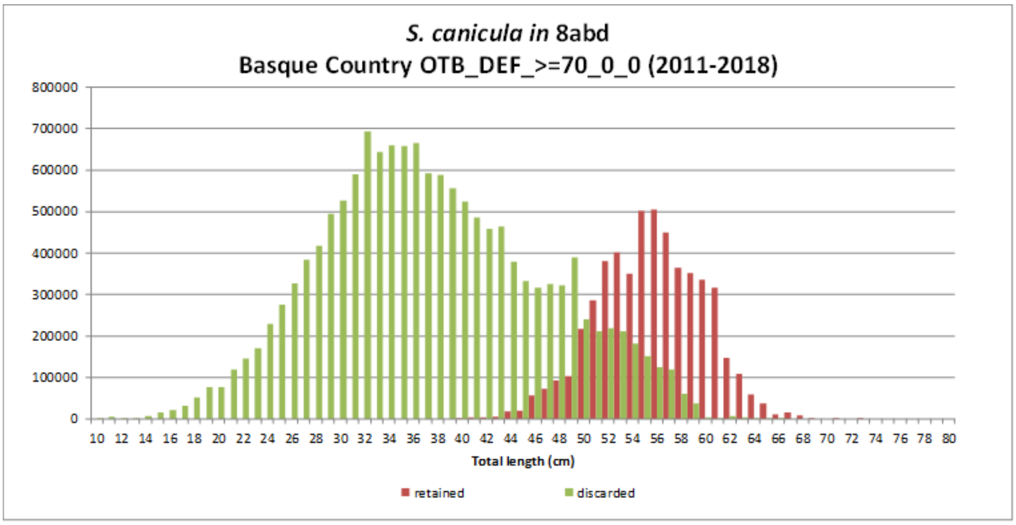


Figure 25.1a. Catsharks (Scyliorhinidae) in the Northeast Atlantic. Length frequencies of *S. canicula* retained (in red) and discarded (green) recorded from the trawl fleet of the Basque country from 2011 to 2018 in ICES divisions 8.a-b, d.

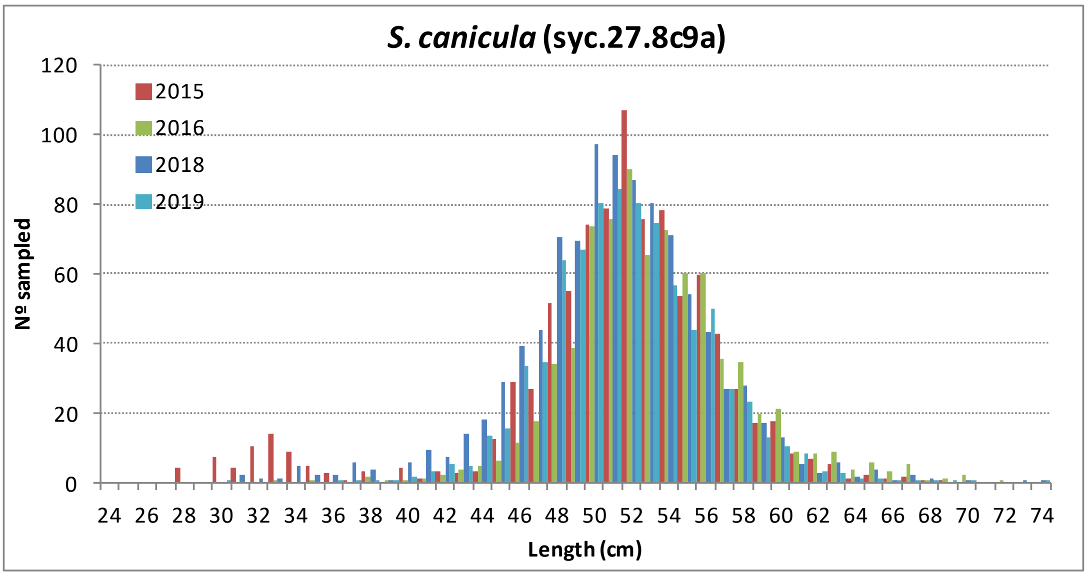


Figure 25.1b. Catsharks (Scyliorhinidae) in the Northeast Atlantic. Length frequency distribution of *S. canicula* recorded from the Spanish trawl fleet in ICES areas 8.c and 9.a landed from 2015 to 2019.

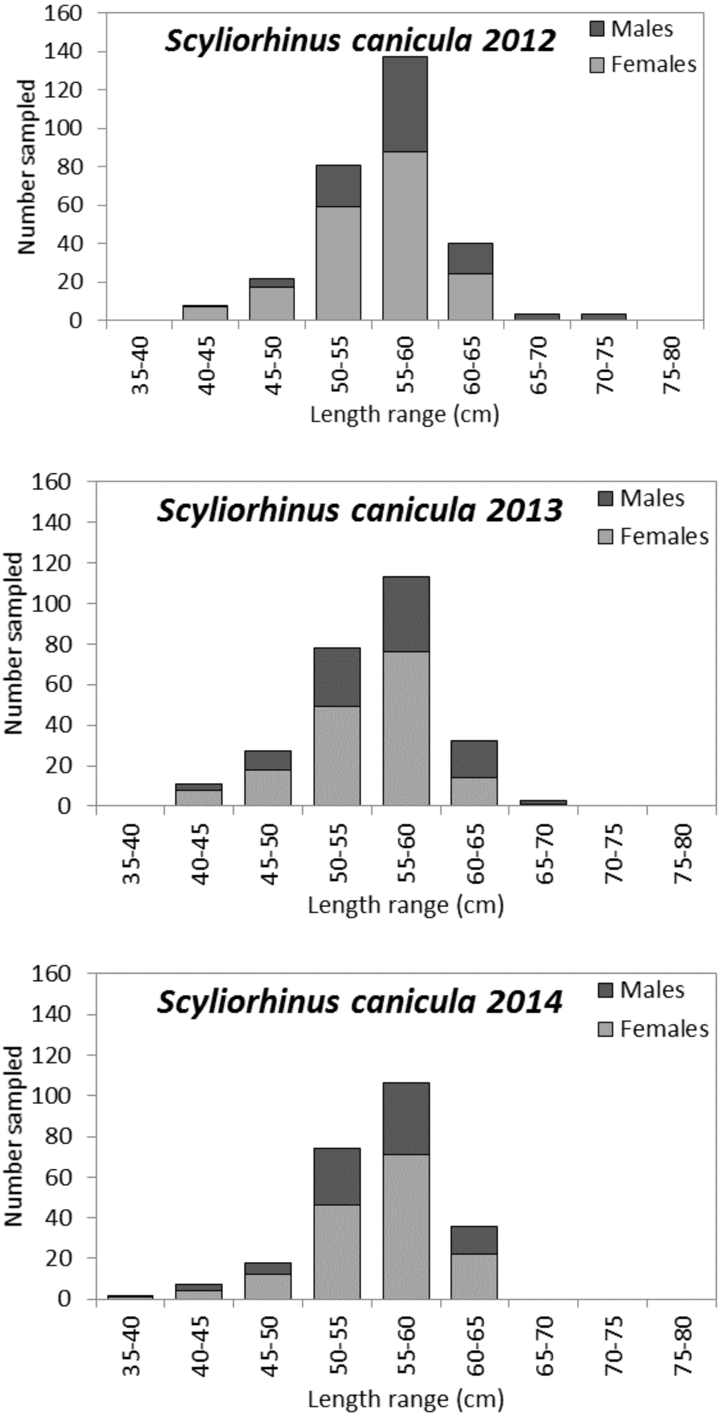


Figure 25.2. Catsharks (Scyliorhinidae) in the Northeast Atlantic. Length–frequency distribution of *S. canicula* measured during a pilot market sampling programme of the Dutch beam trawl fleet (2012–2014).

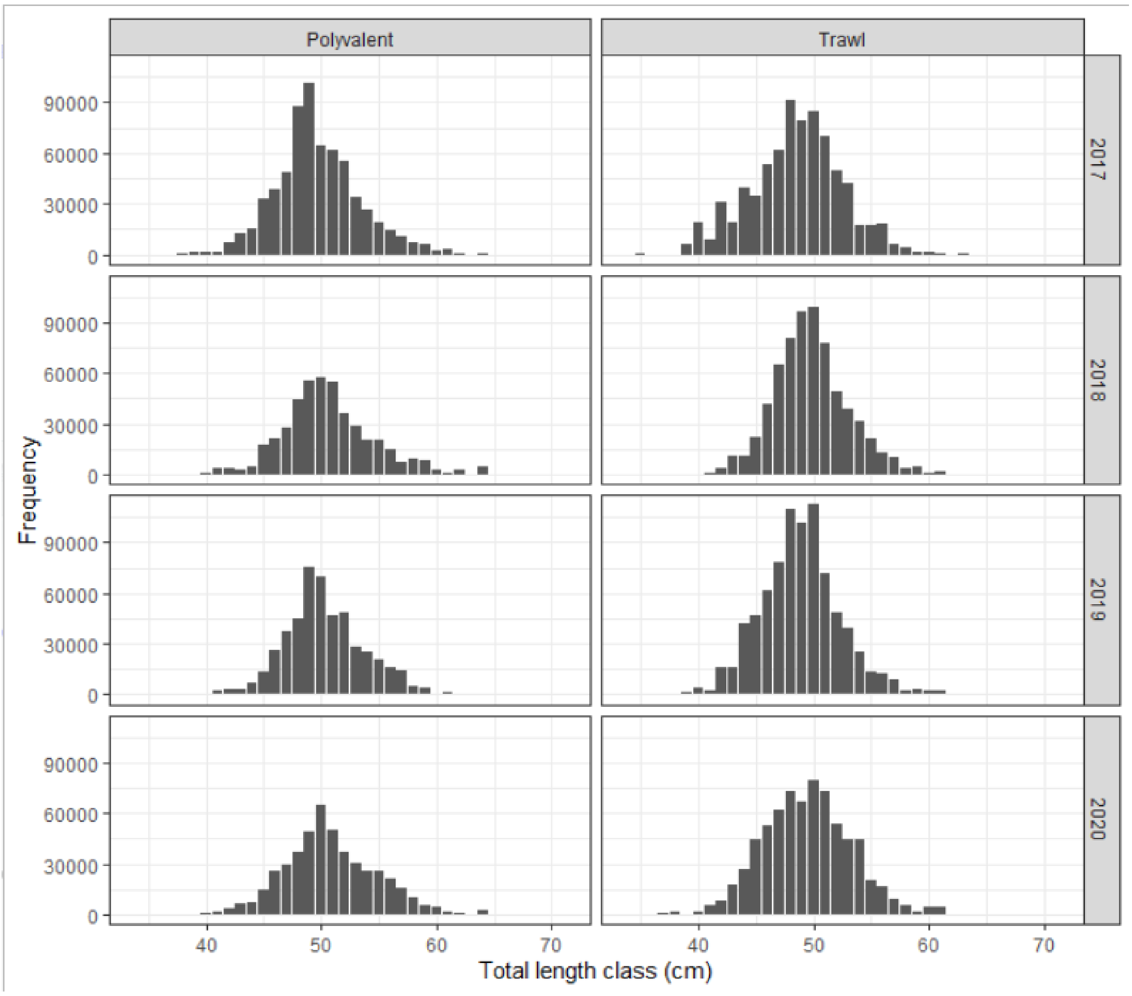


Figure 25.3a. Catsharks (Scyliorhinidae) in the Northeast Atlantic. Length–frequency distribution of *S. canicula* from specimens sampled at Portuguese landing ports from polyvalent and trawl fleets raised to total landings (2017–2021).

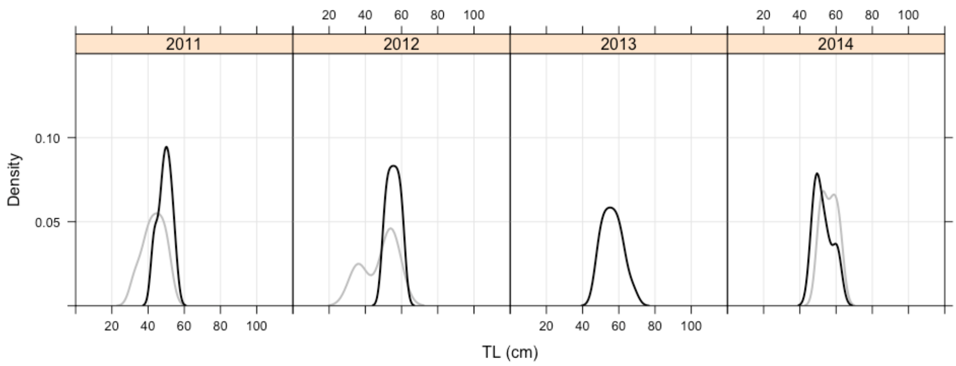


Figure 25.3b. Catsharks (Scyliorhinidae) in the Northeast Atlantic. Length frequency distribution of *S. canicula* retained (black) and discarded (grey) fractions observed onboard vessels using set nets, between 2011 and 2014. The length frequencies were not raised to the total landings. n = 227 sampled individuals.

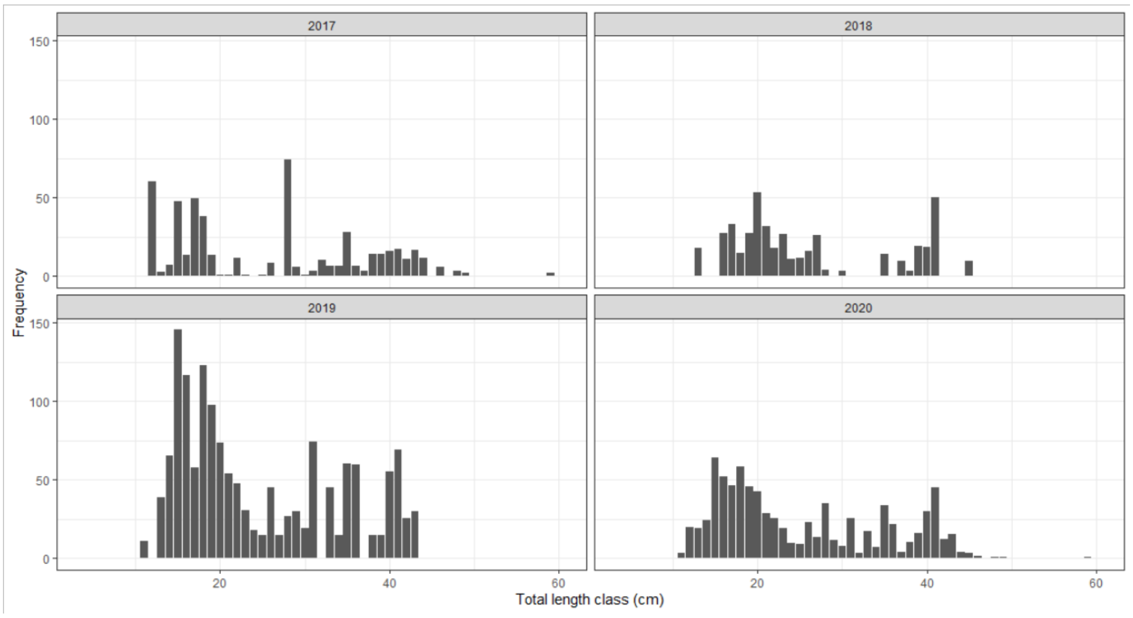


Figure 25.3c. Catsharks (Scyliorhinidae) in the Northeast Atlantic. Length frequency distribution of *G. melastomus* of discards in the Portuguese trawl fleet (OTB_CRU_55; 2017- 2020).

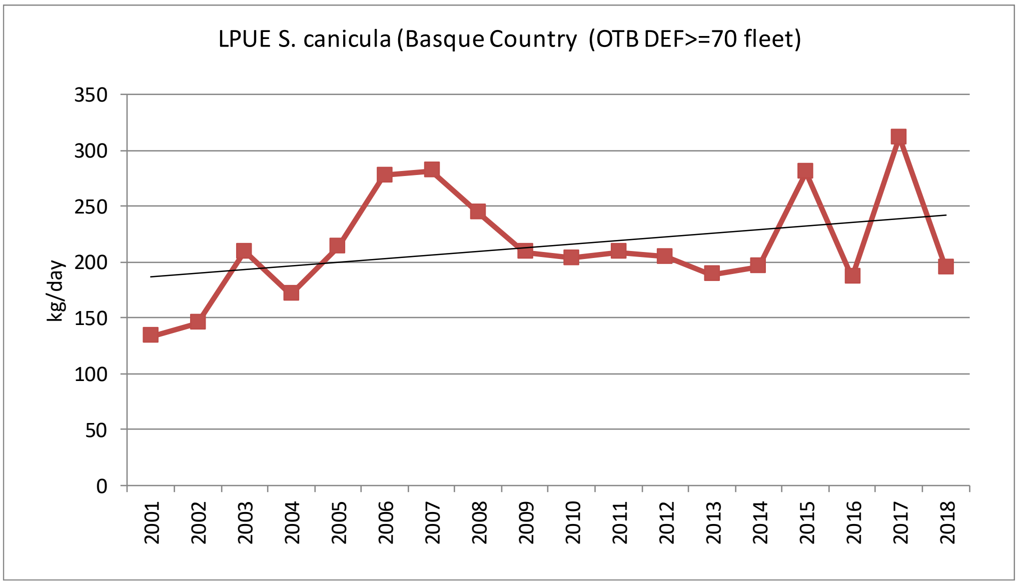
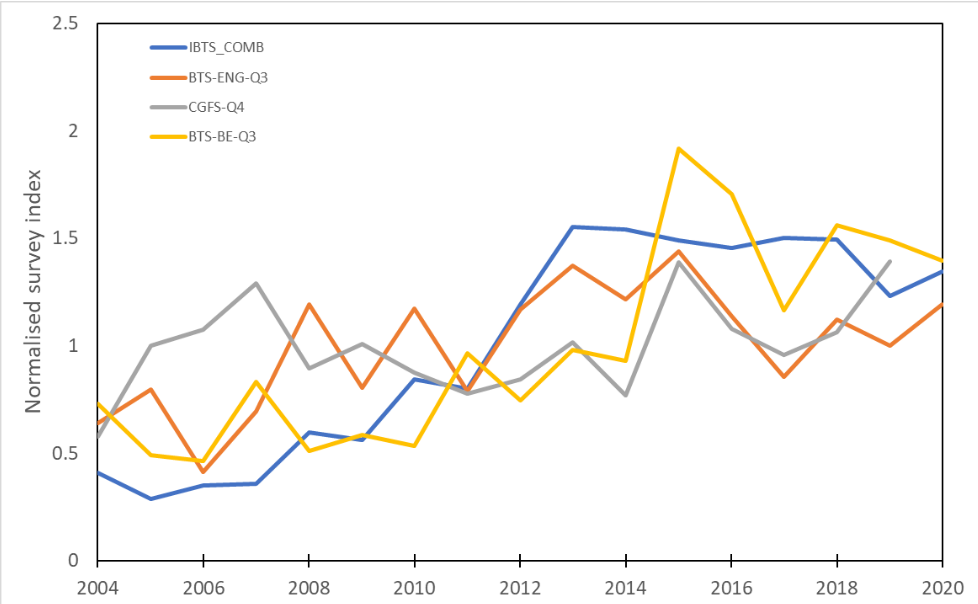


Figure 25.4. Landings per unit of effort data (LPUE) from the Basque Country trawl fleet (OTB_DEF_70) in ICES divisions 8.a-b, d) for *S. canicula*.



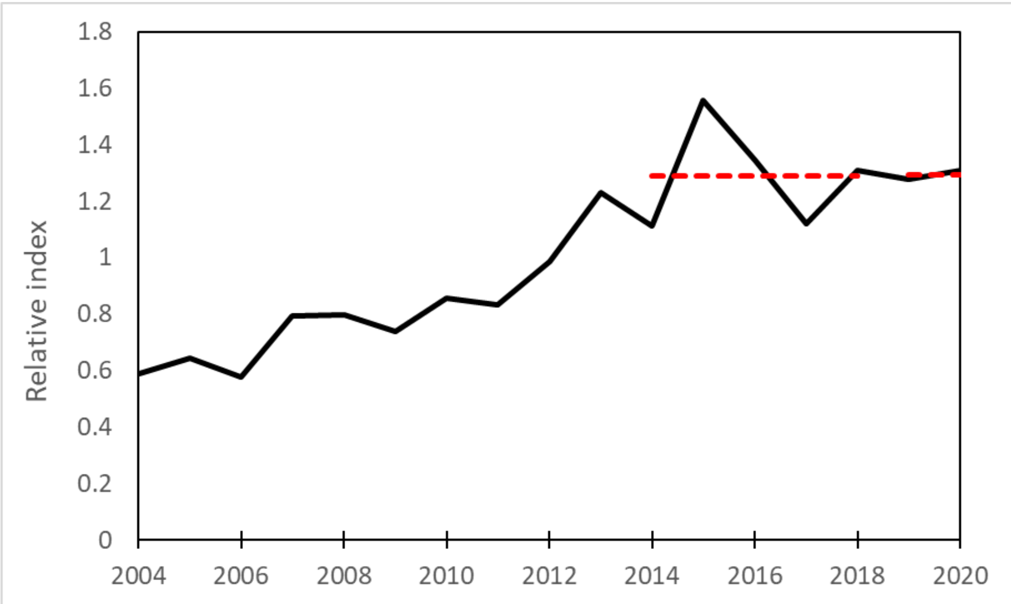


Figure 25.5a. Catsharks (Scyliorhinidae) in the Northeast Atlantic. *Scyliorhinus canicula* in the North Sea, Skagerrak, Kattegat and eastern Channel. Standardised survey indices from five surveys the combined IBTS-Q1 and Q3, CGFS-Q4, BTS-Eng-Q3, and BTS-BEL-Q3 (top) and overall stock size indicator (bottom) for the time period 2004–2020. Dotted lines indicate the average of the last two years and the average catch for the preceding five years.

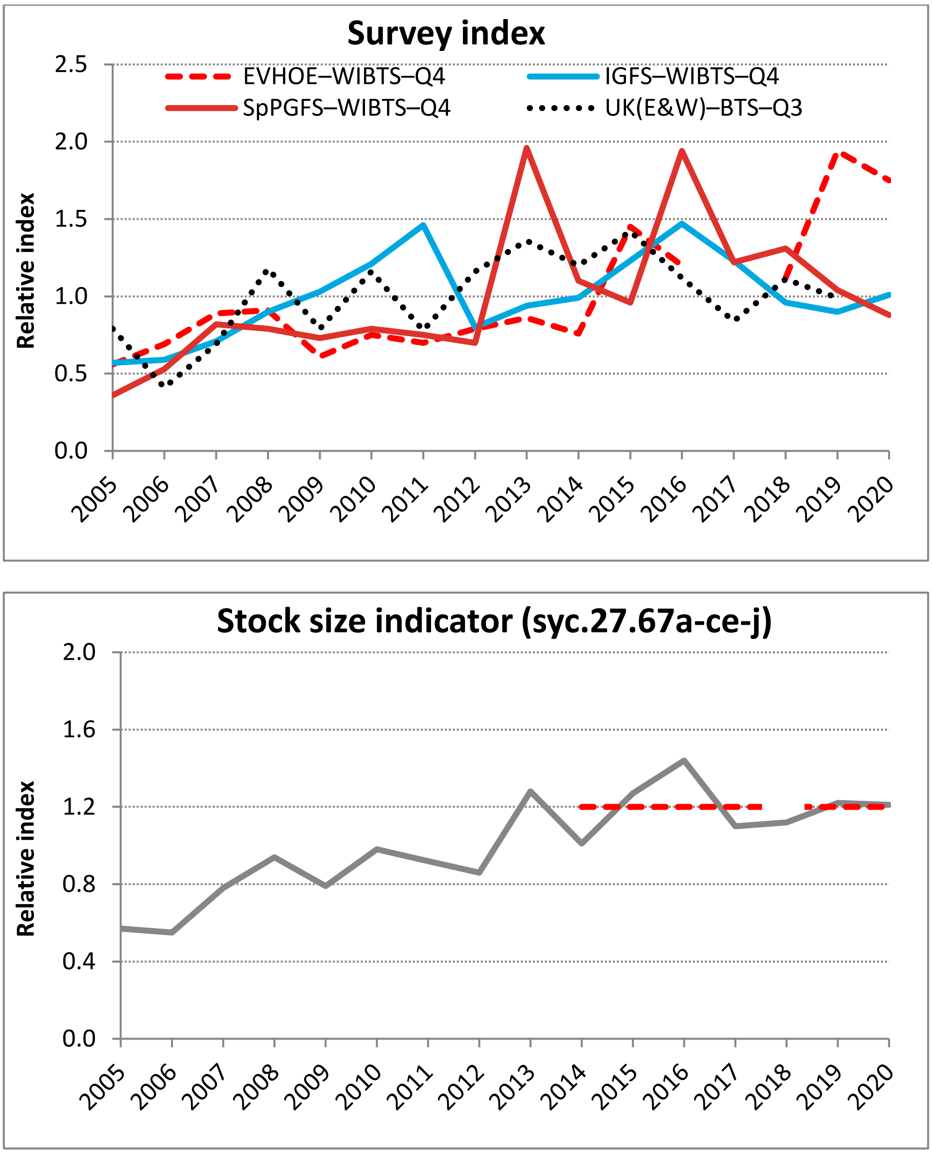


Figure 25.6a. Catsharks (Scyliorhinidae) in the Northeast Atlantic. *Scyliorhinus canicula* in the Celtic Seas Ecoregion. Standardised survey indices from four surveys IGFS-WIBTS-Q4, Spanish Porcupine Bank survey SP-PORC-WIBTS-Q3, UK-(E&W)-BTS-Q3, EVHOE-WIBTS-Q4 (top) and overall stock size indicator (bottom) for the time period 2005–2020. Dotted lines indicate the average of the last two years and the average catch for the preceding five years.

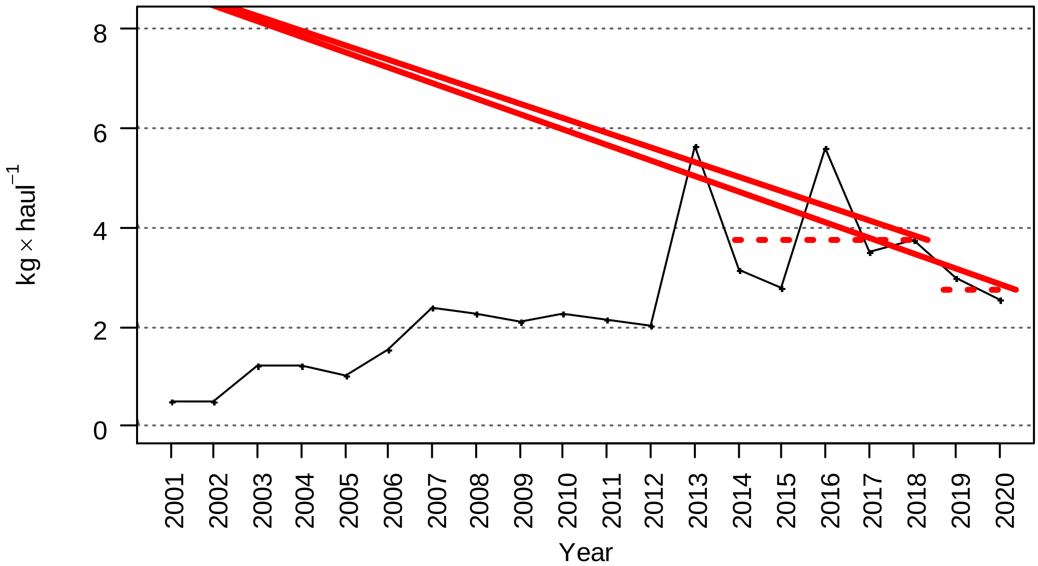


Figure 25.6b. Catsharks (Scyliorhinidae) in the Northeast Atlantic. Changes in the *S. canicula* biomass index during the Porcupine Bank survey (2001–2020). Dotted lines compare mean stratified biomass in the last two years compared to the preceding five years.

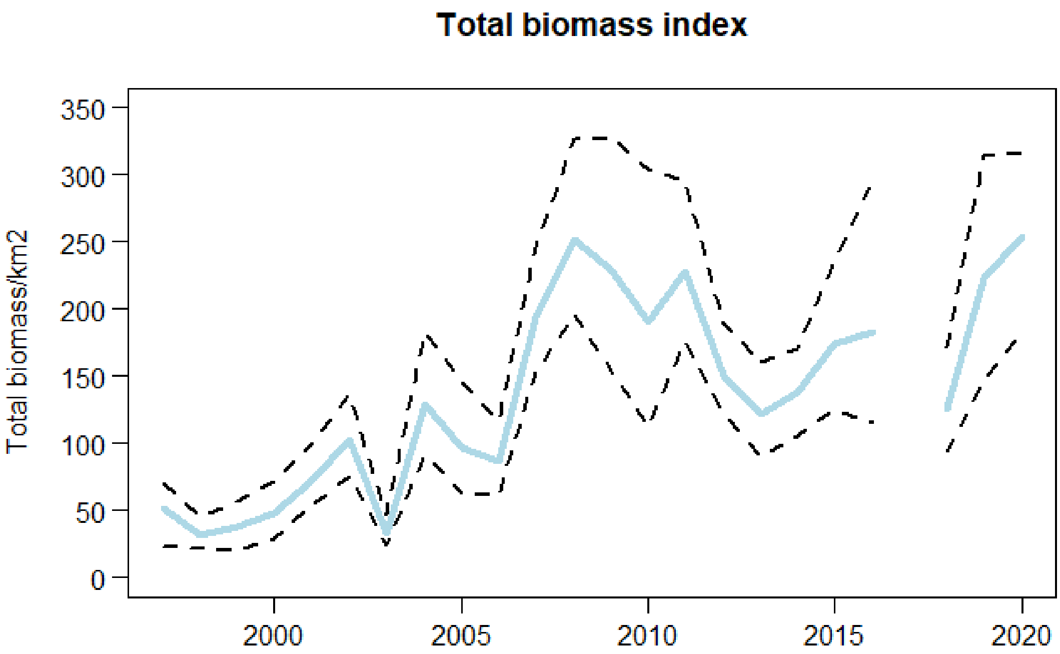


Figure 25.7. Catsharks (Scyliorhinidae) in the Northeast Atlantic. Trends in the stock size of *Scyliorhinus canicula* in the Bay of Biscay (ICES divisions 8.a-b, d), as estimated from the EVHOE survey. Solid line survey index (total biomass.km-^{2}) and dashed line 95% bootstrapped confidence intervals.

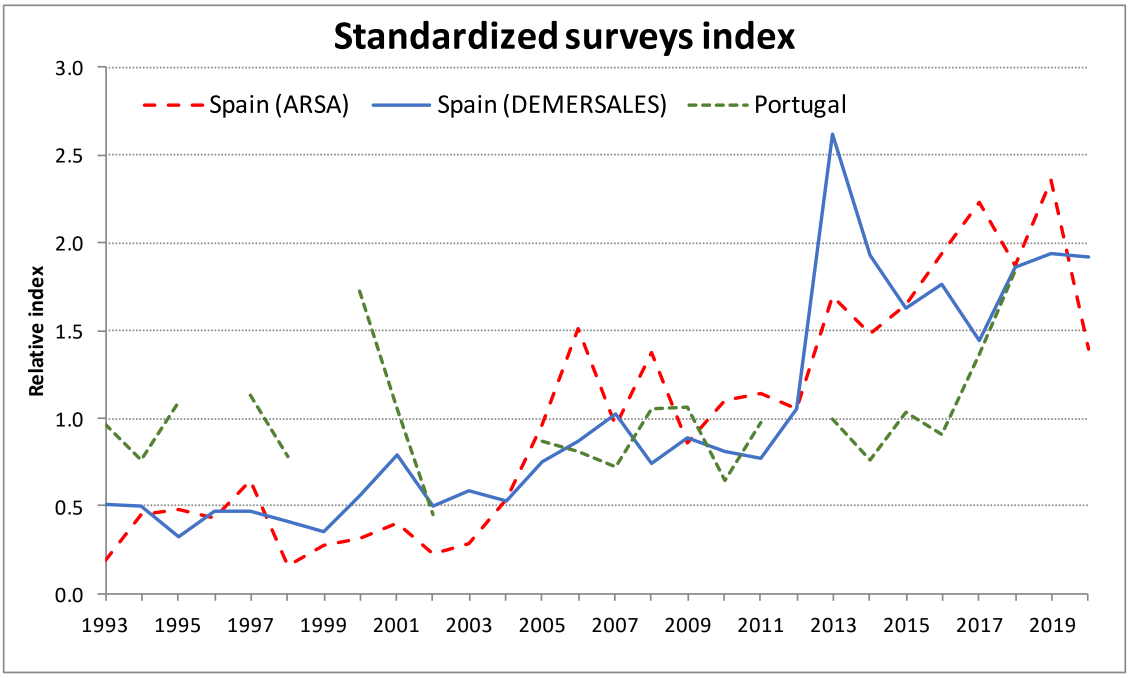


Figure 25.8a. Catsharks (Scyliorhinidae) in the Northeast Atlantic. *Scyliorhinus canicula* in the Atlantic Iberian waters (divisions 8.c and 9.a). Standardised survey indices from three surveys; Spain (ARSA) (average of spring and summer surveys in Gulf of Cádiz), Portuguese PT-GFS and North Spanish Shelf bottom survey (DEMERSALES).

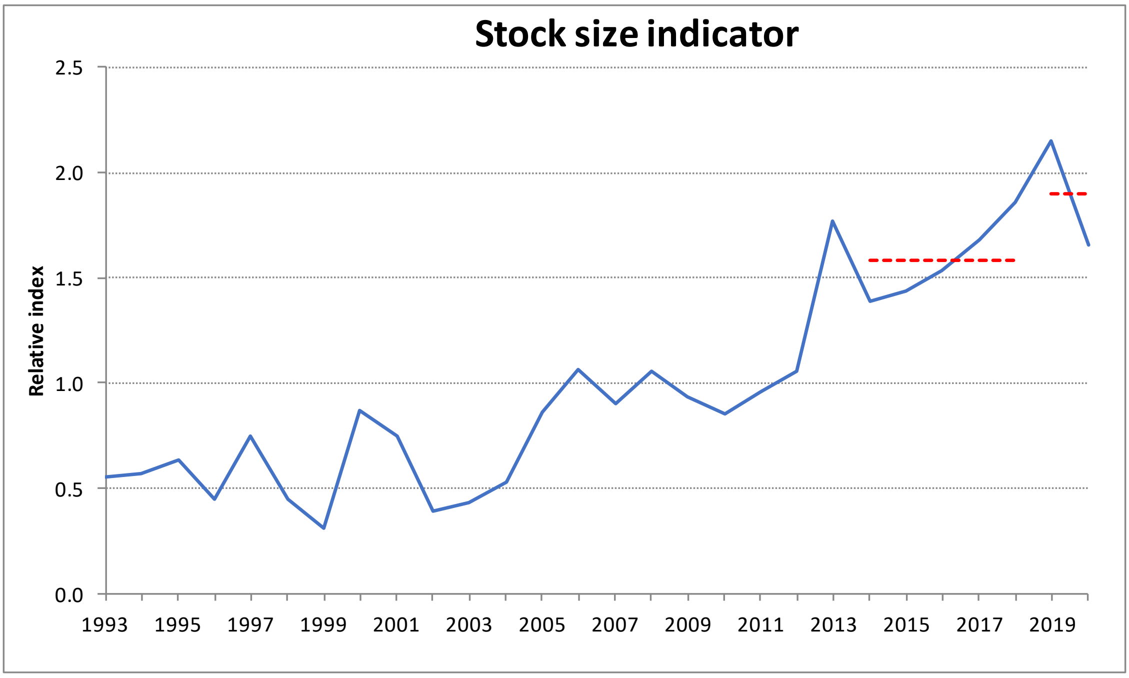


Figure 25.8b. Catsharks (Scyliorhinidae) in the Northeast Atlantic. *Scyliorhinus canicula* in the Atlantic Iberian waters (divisions 8.c and 9.a). Overall stock size indicator combined for these surveys (bottom). Dotted lines indicate the average of the last two years and the average catch for the preceding five years.

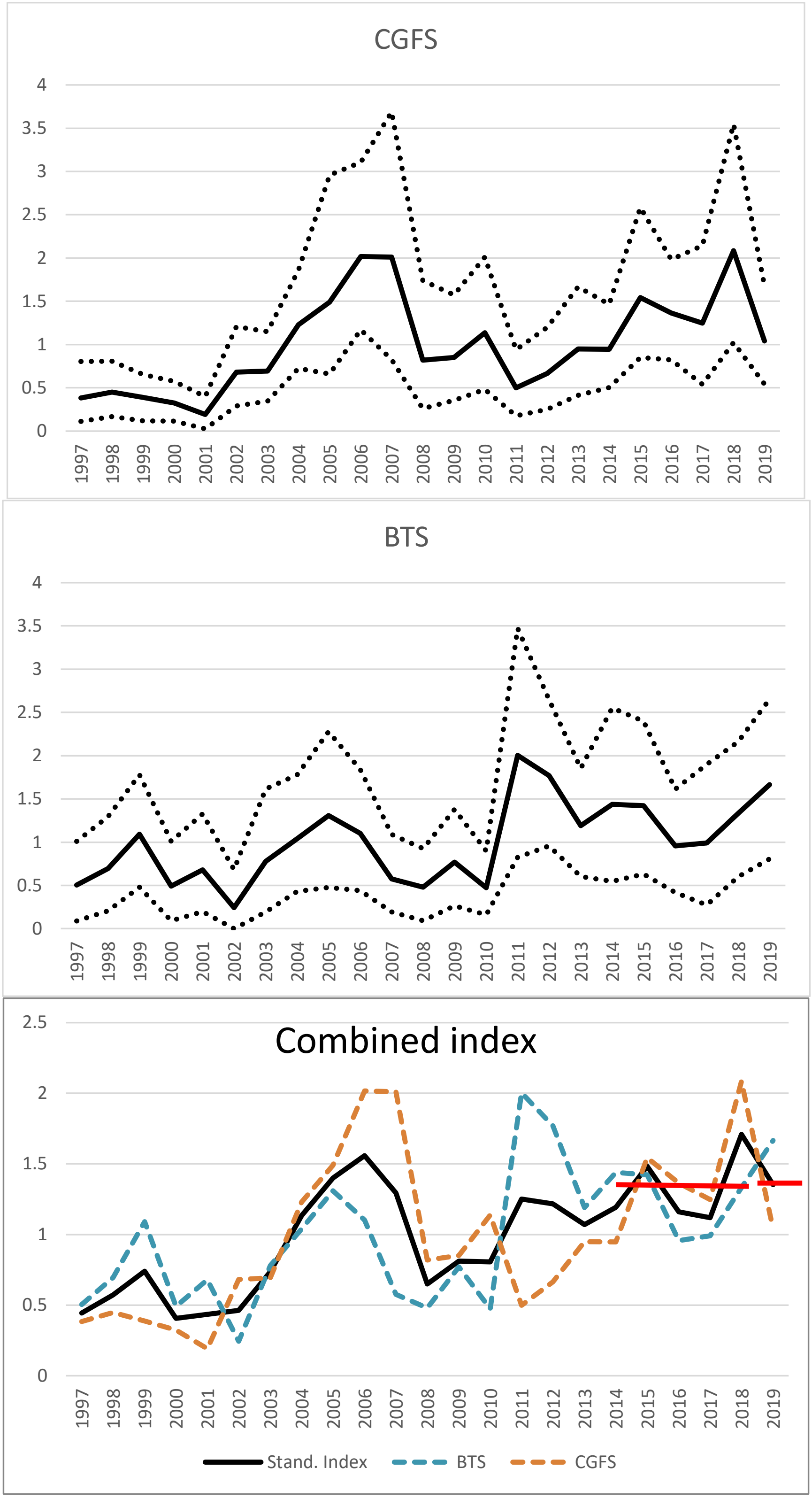


Figure 25.9. Catsharks (Scyliorhinidae) in the Northeast Atlantic. *Scyliorhinus stellaris* in subareas 6 and 7 (Celtic Seas and West of Scotland). Standardized indices of exploited biomass (individuals >50 cm TL) from CGFS-Q3, BTS and combined standardized index red lines represent values for 2019 and 2014–2018 average.

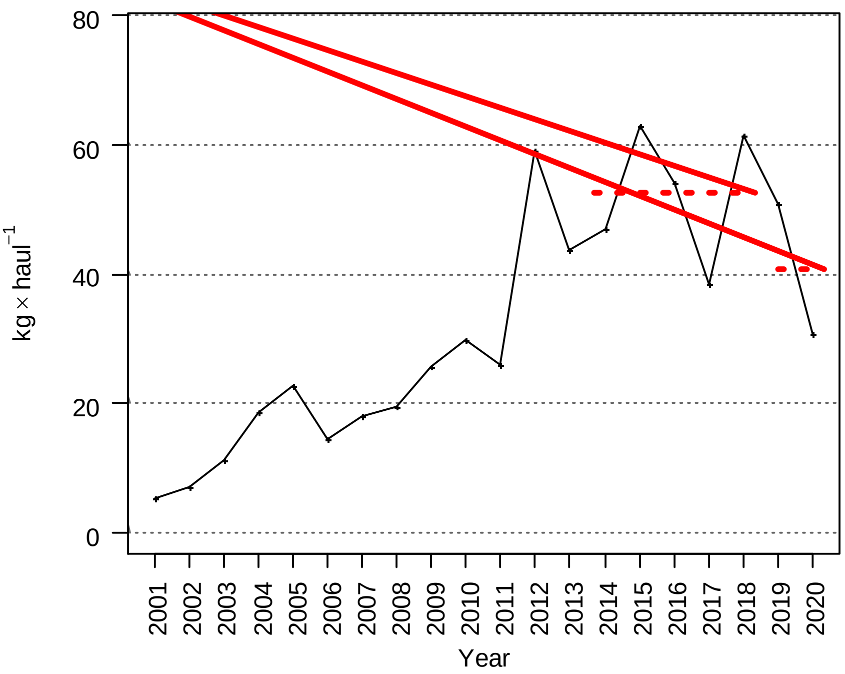


Figure 25.10. Catsharks (Scyliorhinidae) in the Northeast Atlantic. Changes in the biomass index in kg per haul of *Galeus melastomus* during the Porcupine Bank survey SP-PORC-WIBTS-Q3 (2001–2020). Dotted lines compare mean stratified biomass in the last two years and in the preceding five years.

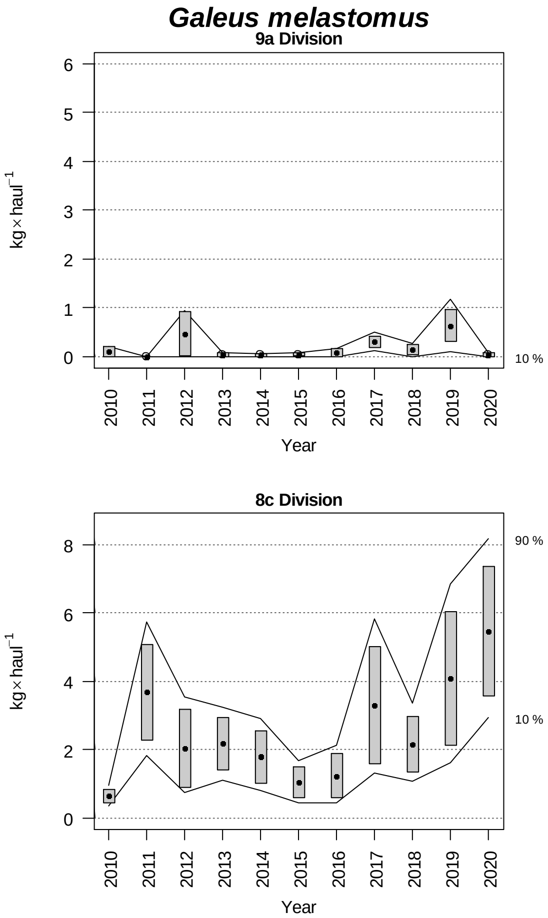


Figure 25.11a. Catsharks (Scyliorhinidae) in the Northeast Atlantic. Changes in *Galeus melastomus* stratified biomass index (only with standard hauls between 70 and 500 m) during the North Spanish shelf bottom trawl survey (SpGFS-WIBTS-Q4) between 2010 and 2020 in the two ICES divisions. Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (P = 0.80 bootstrap iterations = 1000).

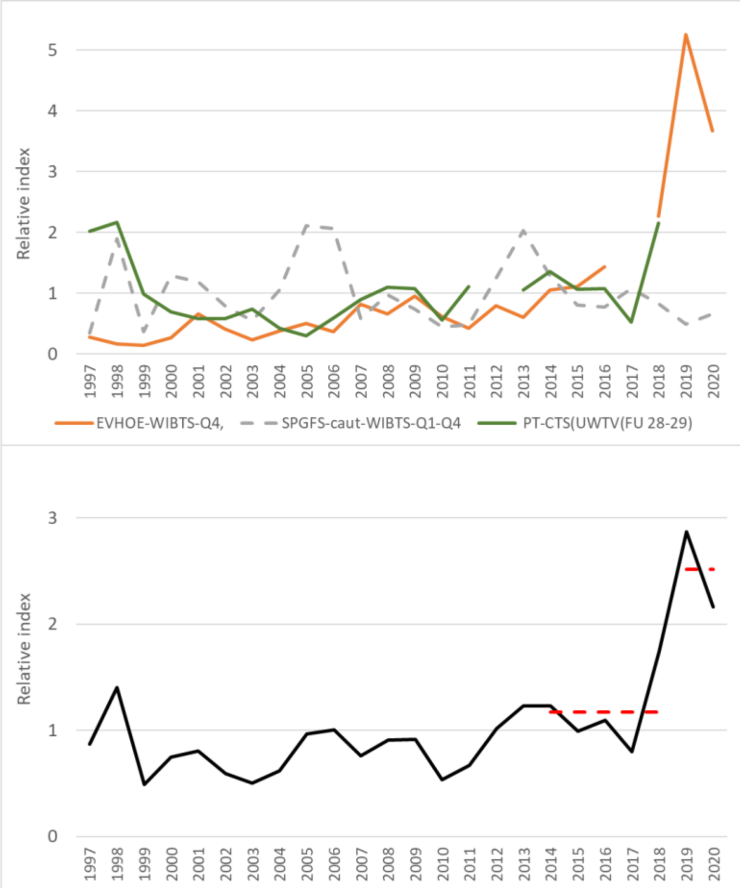


Figure 25.11b. Catsharks (Scyliorhinidae) in the Northeast Atlantic. *Galeus melastomus* in Subarea 8 and Division 9.a (Bay of Biscay and Atlantic Iberian Waters). Standardised survey indices from ARSA (SpGFS-GC-WIBTS-Q1-Q4), Portuguese 9.a (PT-CTS UWTV (FU 28-29)), and EVHOE-WIBTS-Q4 (top) and overall stock size indicator (bottom) for the time period 1997–2020. PT-CTS UWTV (FU 28-29)) was not conducted in 2019 and 2020. Dotted lines indicate the average of the last two years and the average catch for the preceding five years.

26 Common skate

26.1 Available data relating to skates of the genus *Dipturus*

This section addresses the ToR "*Evaluate available data at species-specific level within the common skate-complex (Dipturus spp.) stock units in order to further increase our understanding of each individual species and their current status*".

Given that identification issues relating to the common skate complex may also extend to long-nosed skate *Dipturus oxyrinchus* and Norwegian skate *D. nidarosiensis*, data relating to these species have also been considered where available.

26.1.1 Background

The flapper skate *Dipturus intermedius* (Parnell, 1837) was, as *Raia intermedia*, described originally by Parnell (1837), from specimens caught in the Firth of Forth, on the Scottish east coast. A more detailed description was given in a subsequent account of the fishes of the Firth of Forth (Parnell, 1838). Parnell (1838) considered flapper skate to be "*the connecting link*" between *Raia batis* [=*Dipturus batis*] and *'Raia oxyrhynchus'*, though it should be noted that, based on his description of *R. oxyrhynchus,* Parnell (1838) was discussing white skate *Rostroraja alba* rather than long-nosed skate *Dipturus oxyrinchus.*

Parnell (1838) highlighted the following distinguishing features:

Dipturus intermedius: "… the upper surface of the body being perfectly smooth, without granulation, and of a dark olive colour spotted with white; in the anterior part of each orbit being furnished with a strong spine pointing towards the tail; in the dorsal fins being more remote from each other, and in the anterior margins of the pectorals rather more concave, giving the snout a sharper appearance".

Dipturus batis: "*… the upper surface of the body is rough to the touch, of a uniform dusky grey without spots; the orbits without spines; the dorsals nearly approximate, and the anterior margins of the pectorals nearly straight*".

In a revision of the European skates, Clark (1926) synonymised flapper skate with the common skate, and this perception continued in the scientific literature and field guides (e.g. Stehmann and Bürkel, 1984) for much of the 20th century and early 21st century, over which time data for the two species could have been confounded, including survey data, biological investigations (e.g. Heintz, 1962; Du Buit, 1976) and landings data (e.g. Silva *et al.*, 2012).

Iglésias *et al.* (2010), after undertaking genetic and morphological studies of the large skates being landed in France, confirmed that what was known as 'common skate' was indeed a complex, with this paper suggesting the two species be known as blue skate *Dipturus* cf. *flossada* (Risso, 1826) and flapper skate *Dipturus* cf. *intermedia* (Parnell, 1837).

Iglésias *et al.* (2010) also provided morphometric data and described other morphological features that could help separate the two species, although it should be noted that some of these features are not apparent in juvenile stages. In terms of morphometrics, Iglésias *et al.* (2010) observed that, proportionally, *Dipturus intermedius* had a longer preorbital length; eyes larger; distance from the anterior margin of the orbit to the posterior end of the spiracle is longer; narrower inter-orbital distance; longer inter-spiracular distance; longer inter-dorsal space; and longer snout. The distinguishing morphological features and contrasting life-history parameter, as reported by Iglésias *et al.* (2010), are summarised in Table 26.1.

A subsequent study by Griffiths *et al.* (2010) confirmed the genetic differences within the common skate complex, and provided initial geographical information, with what would equate with flapper skate occurring in the shelf seas west of Ireland, west of Scotland and Shetland Islands, and what would equate with common blue skate occurring on the Rockall Bank, west of Ireland and Celtic Sea. The two species, therefore, have a degree of spatial overlap.

Subsequent taxonomic accounts (e.g. Ebert and Stehmann, 2013[1]; Weigmann, 2016) recognised that the common skate complex comprised two species. However, given that '*batis*' was a Linnean name, this part of the nomenclature was retained, with the scientific name for flapper skate based on the original description by Parnell (1837).

The nomenclature of the common skate complex was stabilised by Last *et al.* (2016), using the names common blue skate *Dipturus batis* (L., 1758) and flapper skate *Dipturus intermedius* (Parnell, 1837). Following this taxonomic revision, an FAO code was introduced for flapper skate (DRJ) which allowed for separation from common blue skate (RJB), although earlier data reported under the latter code would clearly relate to both species.

ICES had previously been requested to provide further information on the distributions of the two species, which was through a Special Request to the EC (ICES, 2012). Whilst some of the current locations of the individual species are becoming better documented, there is still uncertainty in their broader distributions, especially in northern areas (Subarea 2), Icelandic waters (Division 5.a), the Mid-Atlantic Ridge (Division 12), Azores (Division 10) and southern geographical limits in the Biscay-Iberian area (Divisions 8–9).

That *Dipturus intermedius* is most frequent around the western and eastern coasts of Scotland has been supported by the increasing number of scientific studies from these areas (Wearmouth and Sims, 2009; Neat *et al.*, 2015; Benjamins *et al.*, 2018a, 2018b, 2021; Phillips *et al.*, 2021), and, whilst *Dipturus batis* is the more abundant species in the Celtic Sea (Bendall *et al.*, 2012; Brown-Vuillemin *et al.*, 2020), there have also been studies on this species from Scottish waters (e.g. Beard, 1890).

Whilst *"Dipturus batis"* have nominally been reported from more northerly waters of the ICES area, including the Norwegian Sea and Barents Sea (Andriyashev, 1954; Dolgov *et al.*, 2005a, 2005b; Williams *et al.*, 2008), published species-specific data following the recent taxonomic revision are more limited. For example, *D. batis* was not included in the recent atlas of Barents Sea fishes (Wienerroither *et al.*, 2013). In addition to potential, earlier confusion with other *Dipturus* spp., there is also potential for confusion between the common skate complex with spinetail ray *Bathyraja spinicauda*, which also attains a large size (170–180 cm), and the ventral surface of which has a grey margin (Ebert and Stehmann, 2013). The probable incorrect identifications of the common skate complex in northern Norwegian waters was also highlighted by Lynghammar *et al.* (2014), though that study confirmed the occurrence of *D. intermedius* in Norwegian waters.

There have also been nominal records of "*Raja batis*" or "*Dipturus batis"* from the Mid-Atlantic Ridge (e.g. Hareide and Garnes, 2001) and Azores. In terms of the Azores, Santos *et al.* (1997) had previously stated that "*The occurrence of this species in the region needs further documentation*", and whilst there have been subsequent studies referring to the complex (e.g. Menezes *et al.*, 2006; Rosa *et al.*, 2006; Santos *et al.*, 2020), it is uncertain which of the species occurs there.

Whilst earlier accounts generally indicted that "*Dipturus batis*" occurred in the Mediterranean Sea, recent studies have provided limited information regarding whether the complex occurs there (Capapé *et al.*, 2006; Cariani *et al.*, 2017; Serena *et al.*, 2020). Indeed, despite numerous published accounts from the Mediterranean Sea confirming the presence of both *Dipturus oxyrinchus*

[1] Ebert and Stehmann (2013) also recognised an as yet undescribed *Dipturus* sp. from the deeper waters of the NE Atlantic, that is characterised by having notably long and pointed anterior pelvic fin lobes.

(Yigin & Ismen, 2010; Kadri *et al.*, 2015; Mulas *et al.*, 2015; Bellodi *et al.*, 2017; Melis *et al.*, 2018) and *Dipturus nidarosiensis* (Cannas *et al.*, 2010; Follesa *et al.*, 2012; Ramírez-Amaro *et al.*, 2017; Carbonara *et al.*, 2019; Geraci *et al.*, 2019), there seem to no published data that confirms whether either *Dipturus batis* or *Dipturus intermedius* occur in the area. Whilst some recent papers from Mediterranean samples have considered *D. batis* (e.g. Turan, 2008; Benmeslem *et al.*, 2019), the accuracy of the species identification is uncertain and the former study likely relates to *D. oxyrinchus*. In terms of potential historical occurrence, the re-examination of any relevant museum specimens could usefully be undertaken. With increased uncertainty regarding the contemporary occurrence of the 'common skate complex' in the Mediterranean, an improved appraisal of historical information is required, especially since the earlier proposed nomenclature for blue skate (*Dipturus* cf. *flossada*) was based on a description from the Mediterranean coast of France (Risso, 1926; Table 26.2). It is also noteworthy that genetic studies suggest that *Dipturus oxyrinchus* from the Mediterranean and Atlantic are genetically distinct (Griffiths *et al.*, 2011).

The information and distributional data in the available IUCN Red List assessment for common skate (Dulvy *et al.*, 2006) related to the species complex, and separate Red List assessments for common blue skate and flapper skate are currently being finalised. However, the exact distributions of both species remain unclear. Given that many data sources have confounded the two species (and it should also be recognised that taxonomic misidentifications may also affect other members of the genus, including long-nosed skate *Dipturus oxyrinchus* and Norwegian skate *Dipturus nidarosiensis*), improved speciation and validation of the distributional data for all species are required.

The biological stock units for both *D. batis* and *D. intermedius* are also little known, with ICES providing advice for the members of the complex at the ecoregion level. Whilst tagging data are limited, available data do not indicate large-scale movements (e.g. Sutcliffe, 1994; Fitzmaurice *et al.*, 2003; Bird *et al.*, 2020), with Fitzmaurice *et al.* (2003) reporting the longest minimum distance travelled being 120 miles.

Species Distribution Models have indicated that the distribution of *Dipturus intermedius* (in the waters around Scotland) are, among other factors, influenced by distance from shore and depth (Pinto *et al.*, 2016). This study reported that *D. intermedius* appeared to favour waters of 100–400 m that were also relatively close to land, including sea lochs and around islands. In relation to water temperature, Frost *et al.* (2020) reported that *D. batis* occurred in waters of 7.44–13°C and *D. intermedius* in waters of 4.96–15.5°C, with the latter species occurring over a broader temperature range. However, it should be recognised that this study was based primarily on data from the Rockall Bank, Hebridean Shelf and Celtic Sea, and inclusion of other parts of the species' ranges could usefully be considered in future studies.

26.1.2 Synopsis of Icelandic data

This Section was based on the results presented at a recent ICES ASC by Pálsson & Jakobsdóttir (2018) in a poster entitled "*The Flapper or the Blue? D. batis complex in Icelandic waters*". The data presented in this study included the length-distribution from surveys (Figure 26.1), with the majority of samples <160 cm L_T, which was in accordance with the likely length-frequency distribution of *Dipturus batis*. The estimated lengths-at-maturity (Figure 26.2) were 115 cm (males; n = 294) and 119 cm (females; n = 340), and these values were also consistent with the earlier estimates for *D. batis* given by Iglésias *et al.* (2010). Laboratory examination of some retained specimens also indicated that they matched the descriptions provided by Iglésias *et al.* (2010) for common blue skate.

Consequently, available information indicates that the common skate complex in Icelandic waters (Division 5.a) includes *D. batis* only, and that the species is distributed mainly along the southern coasts of Iceland (Figure 26.3).

26.1.3 Synopsis of Norwegian data

Lynghammar *et al.* (2014) reported on the confirmed presence of one individual of *Dipturus intermedius* from the area (65 kg female caught at 58.633°N, 3.917°E in February 2009; Lynghammar, pers. comm.). There have also been some subsequent records of *D. intermedius* from Norwegian waters, including west off Bud, off Florø, near Vatlandsvåg, in the Flekkefjord and off the coasts of southern Norway; Lynghammar, pers. comm.). These records confirm the presence of *Dipturus intermedius* in Norwegian waters of Division 2.a, Subarea 4 and Division 3.a.

26.1.4 Synopsis of data from CEFAS surveys

26.1.4.1 Data available and methods

Ellis and Silva (2021 WD10) summarised those data relating to *Dipturus* that are held on the CEFAS' Fishing Survey System (FSS) database, from both historic and recent surveys, as well as additional data from recent fishery-dependent surveys (2014–2017). Available data relating to the spatial distribution, length and sex composition, and biological parameters from this WD are provided below.

Data relating to the genus *Dipturus* were extracted from the FSS database (08/06/2021), including data for *Dipturus batis, Dipturus intermedius, Dipturus oxyrinchus* and *Dipturus nidarosiensis* (Table 26.3). These data relate to all records available from east of the Mid-Atlantic Ridge and related to data collected over the period 1901–2021, including lengths and biological information (sex, maturity, wing width) for some of the records. This study analysis was conducted using R software (R Core Team, 2020). These data were largely taken as they were recorded with this study as a preliminary overview of the data currently hold and, therefore, further QA/QC procedures should be undertaken if more detailed analyses are required.

Records were summarised according to how catch was processed (e.g. weighed and measured) to account for differences in historical data compared to recent data. Data for the common skate complex (SKT) only relates to the records where specimens were not identified and/or allocated to a specific species. Although, only recently has FSS been able to accommodate these two species separately (SKG and SKF) when recording the catch, there was a brief recent period where although catch records were recorded to the common skate-complex, when collecting additional information on individual weight and maturity, the identification to species-specific was described on a comments field within the database, and therefore a retrospective re-allocation of these individuals to the particular species was possible (these amendments still need to be made to the original data held on FSS and also on DATRAS) .

Spatial distributions are not shown as such, due to changes in spatial coverage changing over the study period, therefore, only maps of presence (positive hauls) for each species were produced. The hauling positions were used instead of shoot positions as the latter may require further investigation on some outliers (in historical data). Length-frequency distributions were produced for each species, by sex when available, and these were separated by either time period or survey type, depending on the species and quantity of data available.

Length-weight distributions were calculated for total length (L_T, measured to the cm below) and total weight (W_T, g), using the exponential relationship ($W_T = a \times L_T^b$), with conversion factors obtained using a linear regression through natural logarithmic transformation. No outliers were removed from these relationships for this study.

Additionally, the linear relationship between L_T and wing width (D_W, measured to the cm or 0.5 cm below) was also calculated by species where data were available. One record was deemed unsuitable, with potential for correction pending further investigations.

26.1.4.2 Results and discussion

There were 1599 records of *Dipturus* held on FSS (Table 26.4), noting that this refers to station records with accompanying data for the various species. These data, which included fish that had been measured, weighed, counted or observed (noting that data collection on historical surveys was more variable), can be used to examine geographical distribution, in terms of presence only.

The survey coverage has varied over time, with some historical surveys extending into northern areas, whilst recent CEFAS surveys have generally been confined to the North Sea and Celtic Seas ecoregions (Subareas 4 and 7). Consequently, these data cannot be used in isolation to examine temporal changes in species distributions.

Spatial distributions

The distributions of all species shown will not be representative of the wider range and it should be noted that survey hauls with no records of any of the species are not shown here. Furthermore, given the longer-term taxonomic confusion in these species, outlier records should be interpreted with extreme caution.

The available distributional data, by time period, for both members of the common skate complex indicate that they are distributed widely around the British Isles (Figure 26.4). More recent data, which have been separated between the two species (Figure 26.5) show that *D. batis* is recorded relatively frequently in the Celtic Sea and western English Channel, with occasional specimens in the Irish Sea, North Sea and Irish Sea. *Dipturus intermedius* was recorded in the northern North Sea and in the Celtic Sea. It should be noted that the surveys used in this study do not include those waters west of either Scotland or Ireland.

Data for both *Dipturus oxyrinchus* and *D. nidarosiensis* were more limited (Figure 26.6). It should also be noted that it is possible that *Dipturus intermedius* may have been misidentified as one of either of these species, if specimens were simply being viewed as being different from *Dipturus batis*. For example, juvenile *D. intermedius* have a much darker ventral surface than *D. batis*, and so the reported presence of *D. nidarosiensis* in the Celtic Sea could relate to juvenile *D. intermedius* (noting that the lengths of these two specimens were 29 and 37 cm). Indeed, it has not been possible to authenticate any of the nominal records relating to *D. nidarosiensis*. In terms of *D. oxyrinchus*, recent, authenticated captures have been made along the western slope of the Norwegian Deep, with some of the other records, especially those from shallower areas, potentially questionable.

Length-frequency

Length data were available for 3950 individual *Dipturus* (Table 26.5), with the majority of these (61.9%) coming from dedicated surveys on a commercial gillnetter, with various otter trawl surveys in the south-west (DCRDC, Q1SWOTTER, Q4SWIBTS and WCGFS) and beam trawl surveys in the southwest (Q1SWBEAM) accounting for 9.0% and 5.3% of measured individuals, respectively. North Sea surveys (NSGFS, IBTS3E and IBTS4E) accounted for only 1.2%, with various historic surveys (HISTORIC and HISTORWEST, including research vessels and chartered fishing vessels) accounting for 22.5%.

The overall length-range reported at the complex level (SKT; Figure 26.7) was 10–217 cm. However, the smaller individuals recorded are probably misidentified (or from confusion of the use of the generic term 'skate' in earlier logbooks), as these sizes would be below the length-at-hatching. More recent data collected just on-board RV CEFAS Endeavour (2003–present; SKT, SKF and SKG) indicated that the smallest individuals were 18 cm.

The length-frequency distribution of specimens identified as *Dipturus batis* ranged from 18–136 cm (scientific trawl surveys) and 29–149 cm (chartered surveys on a commercial gillnetter). Scientific trawl surveys generally caught proportionally smaller *D. batis*, generally <120 cm, whilst the commercial netters were more selective for larger individuals, with one peak at ca. 70–110 cm and a main peak at 110–140 cm (Figure 26.8). Data were more limited for *D. intermedius,* which were recorded over a length range of 34–195 cm (Figure 26.9).

Biological parameters

Data relating to the length-weight relationship, including a summary of earlier published data, are summarised (Table 26.6) with data analysed presented in Figure 26.10. Available data on the relationships between total length and disc width, or wing width (Figure 26.11) indicate no obvious difference between *D. batis* and *D. intermedius*, though more data are certainly required to better examine this. Similarly, maturity data are also limited (Figure 26.12), though it should be noted that on-going tag-and-release protocols on CEFAS trawl surveys means that the collection of maturity data for females is particularly limited.

Biological studies on the life-history parameters for both species are limited, with earlier studies potentially confounding the two species (e.g. Du Buit, 1976; Fahy, 1991), and so further biological data collection is required, particularly in relation to sampling of dead bycatch.

26.1.5 Synopsis of French data

26.1.5.1 IFREMER

D. batis and *D. intermedius* are now frequently caught in the Celtic Sea during the EVHOE survey. The distinction between the two species in IFREMER data began in 2018, although species identification has been made on board by scientists from MNHN for previous years. This will ultimately make the derivation of stock size indices for *D. batis* since 2009 possible.

Sample sizes from the onboard observation programme (DCF) are generally too low to derive estimates of discarded *Dipturus* at the scale of the stock. However, the proportion of skippers reporting discards of *D. batis* and *D. intermedius* has been increasing.

An ongoing French project focusing on *D. batis* in the northern Bay of Biscay and Celtic Sea involves self-sampling by voluntary crews of bottom trawlers working in the area. The project started in autumn 2019 with two vessels, and a total of five vessels are now involved. For every fishing operation, the number of individuals caught is reported. *D. batis* are also sexed and measured for some fishing operations on a random basis. In addition, an exemption has been obtained to land samples of large female *D. batis*. These are then examined in order to estimate ovarian fecundity. The project is due to end in June 2021, but self-sampling will be prolonged beyond this date. The data collected will be used to provide estimates of body size distributions and distribution maps.

26.1.5.2 Muséum national d'Histoire naturelle (MNHN)

This section is based on some of the results presented by Barreau and Iglésias (2021 WD12). Between 2006 and 2016, the French National Museum of Natural History (MNHH) has collected data on the common skate complex, including data from fish auctions, opportunistically from fishers and during surveys onboard commercial fishing vessels, mainly in the Celtic Sea. Most data were collected between 2013 and 2016 within a dedicated program “POCHETEAUX”. Dead individuals have been dissected when possible. These studies have also provided data for other *Dipturus* spp., but these data are not shown here.

Species distributions (Figure 26.13)

Only one trip took place off North West Scotland, with this trip onboard a vessel specialized in deep-water fishing. Data from this trip showed a higher proportion of *D. intermedius* compared to *D. batis*. In contrast, the other trips were undertaken on the continental shelf of the Celtic Sea, with a higher proportion of *D. batis.* The southernmost individual of *D. intermedius* observed was caught by a fishing boat near the Rochebonne Bank in the Bay of Biscay in May 2014. This specimen was an adult female of 193.4 cm length. Several specimens of *D. batis* were collected in the northern part of the Bay of Biscay. They were reported by professional fishermen or found in auctions in 2014 and 2015 and related to immature individuals (54.6–110.5 cm).

Depth distribution (Figure 26.14)

Common blue skate were recorded during fishing trips at sea over a depth range of 108–630 m (Barreau *et al.*, 2016), but was observed to be more abundant in shelf seas as depths of around 120 m. In contrast, *Dipturus intermedius* had a larger depth range, being observed at depths of 114–1000 m (Barreau *et al.*, 2016). Both species occur on soft (sandy-muddy) bottoms.

Length-frequency distribution (Figure 26.15)

Data on length are represented in 10 cm sizes classes. *Dipturus batis* showed a typical size distribution for a skate population with the presence of two peaks. The first one represents the young individuals, while the second one is due to the accumulation of mature individuals in a larger size class as growth slows down once maturity is attained. The observed length-frequency distribution of *D. intermedius* was more erratic, due to the more restricted sample size. For both species, the larger individuals were mainly female, though the overall sex ratio is close to 1:1.

Length-weight relationships

Data on the relationships between total length and gutted weight were collected by sex and species during the POCHETEAU project (Figure 26.16, Table 26.6). Meaningful data relating to total weight were only available for *Dipturus batis* caught in the Celtic Sea (Figure 26.17, Table 26.6) as the number of *D. intermedius* was too low.

Length-disc width relationship

Tails of skates are often cut of damaged, and so the relationship between total length (L_T) and disc width (D_W) allows the total length of damaged specimens to be estimated. There are also some historical studies or sampling datasets where the disc width rather than the total length was measured. Total length-disc width relationships (mm) were calculated for both species (Figure 26.18) and were defined by the following relationships:

Dipturus batis $D_W = 0.7075\ L_T + 9.3838$ ($n = 1374$, $r^2 = 0.997$)

Dipturus intermedius $D_W = 0.7836\ L_T - 38.255$ ($n = 115$, $r^2 = 0.998$)

Length-at-maturity

Data from Iglésias *et al.* (2010) estimated the length at 50% maturity (L_{50}) at 115.0 cm (male) and 122.9 cm (female) for *D. batis* and 185.5 cm (male) and 197.5 cm (female) for *D. intermedius*. The age at 50% maturity was tentatively suggested as 11 years and 19–20 years for *D. batis* and *D. intermedius*, respectively. More recent studies for *D. batis* were used to estimate the length at 50% maturity, using the package "sizeMat" and the function "gonad_mature" on R software (https://cran.r-project.org/web/packages/sizeMat/index.html). The length at 50% maturity (L_{50}) was estimated at ca. 115 cm for males (Figure 26.19). Two estimates of L_{50} were calculated for female, one based on dissected specimens, and another based on the assumption that all females <90 cm were immature and that female caught alive but not dissected were mature if a flaccid cloaca was observed. L_{50} results of these two approaches were 117.5 cm and 119 cm respectively.

26.1.6 Synopsis of Spanish survey data for the Porcupine Bank

This section was based on some of the results presented by Fernández-Zapico *et al.* (2021 WD03). Three species of the genus *Dipturus* were reported on in this document: *Dipturus batis, D, intermedius* and *D, nidarosiensis*. Some of these data (pre-2011) are presented here at the genus-level.

The overall biomass and abundance of *Dipturus* spp. decreased in 2020 compared to the previous years (Figure 26.20), with the mean biomass index from the last two years below that of the previous five years (Figure 26.21). However, current catch rates are still above those reported during the first part of the time-series (2001–2011).

Species-specific data were available for more recent years, with this indicating that the biomass and abundance of *D. batis* decreased to among the lower values of the time-series. However, the abundance and biomass of the other two species were similar to earlier values (Figure 26.22).

Dipturus nidarosiensis was reported from some of the deeper parts of the survey area (457–1025 m deep), to the south of Porcupine Bank. *Dipturus batis* was reported at depths of 282–409 m close to the Bank, whereas *D. intermedius* was found in waters of 191–1025 m depth (Figure 26.23)

In 2020, the few specimens of *D. nidarosiensis* recorded were in the 26–188 cm length range, whilst the specimens of *D. batis* (28–97 cm) and *D. intermedius* (24–115 cm) reported were slightly smaller than observed over the longer time-series (Figure 26.24). Indeed, the larger-sized individuals reported in the previous 10 years were not recorded in 2020. It is noted that the tow duration has been reduced from 30 min to 20 min since 2016, and it is unclear as to whether this reduction in tow duration would impact on the sampling of larger skates.

Available data confirm that both members of the common skate complex occur on and around the Porcupine Bank, with Norwegian skate also occurring in deeper waters. *Dipturus batis* was found to be the main species of the complex occurring in this area.

26.1.7 Synopsis of Portuguese data

This section was based on the results presented by Serra-Pereira *et al.* (2021 WD08). This WD summarize the available information for *Dipturus* spp. from mainland Portugal (Division 9.a), including data from the DCF commercial sampling and from surveys, to inform on landings, spatial distribution, and length ranges for *Dipturus oxyrinchus*. The data presented reinforces the current perception that *D. oxyrinchus* is the main *Dipturus* species occurring in Division 9.a, with some anecdotal observations relating to *D. nidarosiensis.*

Since 2016, Portuguese data for *Dipturus oxyrinchus* (Division 9.a) have been included in the 'Other skates and rays in Subarea 8 and Division 9.a (Bay of Biscay and Atlantic Iberian waters)' stock. No misidentifications with other *Dipturus* spp. have been recorded by the DCF sampling programme of Portuguese landings, so these data are not presented with the common skate *Dipturus batis*-complex (rjb.27.89a).

Misidentifications and/or coding errors in landings data, as observed in other areas, occur in Division 9.a, with Rajidae being commonly landed under incorrect commercial denominations. To address this, IPMA developed a statistical procedure to estimate species-specific landings during the DCF skate pilot study (2011–2013; Figueiredo *et al*., 2020). The output from this procedure is the basis for the annual reported ICES landing estimates from Portugal, since 2008, including those for *D. oxyrinchus.* No other *Dipturus* species have been identified by DCF in landing ports over this time.

The estimated landings of *D. oxyrinchus* from Division 9.a (2008–2020) are presented in Figure 26.25 by fleet segment. Landings from the polyvalent fleet accounted for about 80% (56–99%) of the total landings. For the polyvalent fleet, landings were mostly recorded from the 'Centro' and 'Lisboa e vale do Tejo' regions, more specifically in the landing ports of Peniche and Sesimbra, respectively (Figure 26.26). The same was observed for the trawl landings, although those in the 'Centro' were less representative.

Length data have been collected during the DCF sampling programme. Due to the low number of individuals measured in some years, the length frequency distribution was combined for the whole time-period (2008–2020) (Figure 26.27). The lengths recorded ranged from 48 to 158 cm, and the overall length-frequency distribution was similar between the two fleets.

Dipturus oxyrinchus is often caught during the Portuguese crustacean trawl survey/*Nephrops* Survey Offshore Portugal (NepS (FU 28–29)), which covers the Portuguese southwestern and southern coasts, along eight sectors (Figure 26.28). This survey has operated since 1997, but was not conducted in 2004, 2010, 2012, 2019 or 2020. More details on the survey characteristics were described in WKSKATE (see Rodríguez-Cabello *et al.*, 2020 WD).

Dipturus oxyrinchus was found at depths of 43–776 m, but was caught more commonly in the southwest (south off Cabo Espichel) at depths of 350–600 m deep, and in the southern region at 400–700 m depth (Figure 26.28–Figure 26.30). The occurrence and spatial distribution of the species varied over the years (Figure 26.29). Lower catches were observed in 2000, 2005, 2008 and the absence in 1999 may be influenced by the use of a net with different characteristics from the standard protocol (i.e., CAM net with 20 mm mesh size).

The length distribution of *D. oxyrinchus* has been variable over the time-series, mainly due it being a rarely recorded species with a wide size range, from 18–160 cm L_T (Figure 26.31). The mean length of the overall time-series was 57 cm, with some years catching more juveniles (e.g. 2016–2018), while in other catching larger individuals (e.g. 2002, 2011, 2012, 2015; Figure 26.32).

During the NepS (FU 28–29) surveys time series, *Dipturus nidarosiensis* was also caught but in very few numbers, with only three individuals identified between 1997 and 2018 (2014: 68.5 cm male, 755 m depth; 2014: 165 cm female, 657 m depth; and 2016: 47.7 cm female, 104 m depth).

26.1.8 Analyses of DATRAS data

This section was based on some of the results presented by Barreau and Iglésias (2021 WD12).

Exchange format data were downloaded from DATRAS for the years 2010–2020. The number of individuals recorded under *D. batis* (here considered as the complex) has decreased in part of the survey to be better ascribed to either flapper or common blue skate (Table 26.7). Taking into account all *Dipturus* spp. captured, it appears that the number of

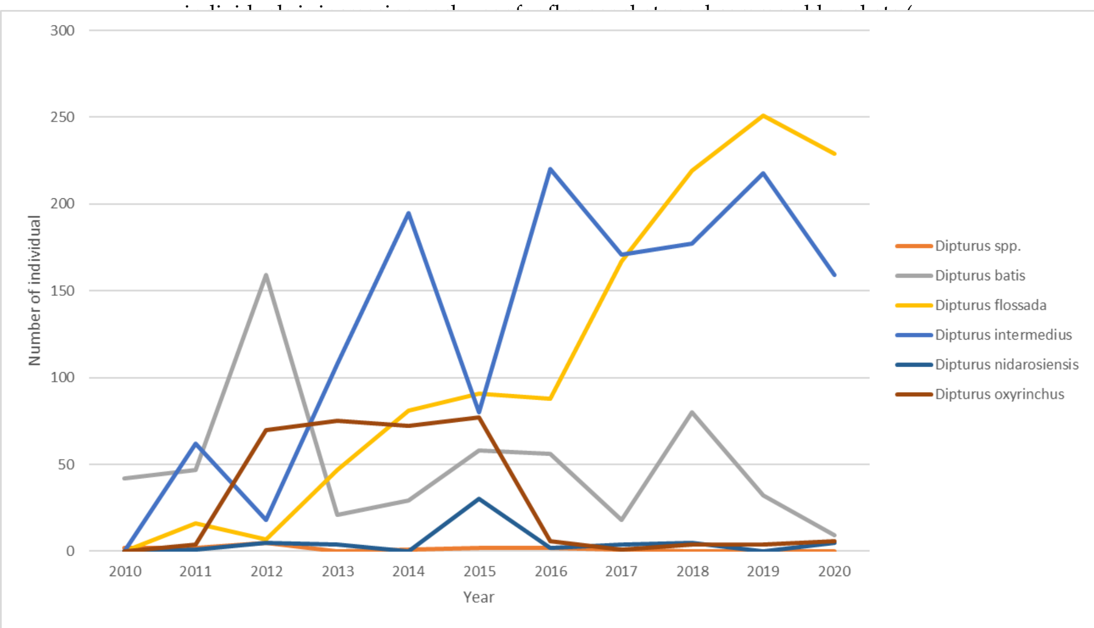


Figure 26.33). Data on depth for *D. batis* complex from DATRAS were from all recorded individuals up to 2015.

The spatial distributions of the two species are now better known from around the British Isles, with the flapper skate mainly around the coasts of Scotland, whilst the common blue skate is observed mostly in the Celtic Sea and on the Rockall Bank (Griffith *et al.*, 2010; Frost *et al.*, 2020), as also confirmed by the available data used here (Figure 26.34).

Available DATRAS data on the depth distribution of the *D. batis* complex were examined for 2010–2015. The common skate complex was present from the coast to about 550 m depth (Figure 26.35). Common blue skate was recorded at depths of 66–320 m but was more abundant in shelf seas at depths <200 m. *Dipturus intermedius* had a broader depth range (17–450 m) and a slightly shallower median depth than *D. batis.*

In order to see if some of the surveys could be relevant to describe temporal trends in the stock, the catch rate in number per hour was calculated for each survey within the last 10 years (Figure 26.36). These preliminary results should not be used to draw conclusions on actual stock trends, as potential changes in gears and survey designs have not been taken into account. They are only informative results on the evolution of the catch per species per survey and to identify which surveys could usefully be subject to closer examination. Common skate complex was observed mainly in BTS since 2013, with records decreasing in the SWC-IBTS/ SCOWCGFS (where improved speciation has occurred since 2015). Common blue skate *D. batis* was recorded mainly on Rockall (SCOROC survey) with the highest catch rates, which increased during the period, followed by EVHOE, IE-IGFS and SWC-IBTS/ SCOWCGFS. All trends suggested an increase catch rates in these surveys. Flapper skate *Dipturus intermedius* was observed consistently during the IE-IGFS and SWC-IBTS/ SCOWCGFS.

Length and sex data were recorded for most of the individuals caught during research vessel surveys (to the cm below). The observed *D. intermedius* size distribution seems coherent with the expected shape described in Iglésias *et al.* (2010), with a high number of relatively small individual and the appearance of a small hump at larger size corresponding to the accumulation of the mature individual into the larger length classes (Figure 26.37). However, the length-frequency distribution of *D. batis* (=*D.* cf. *flossada*) seems incorrect, with several individual >150 cm. This suggests that misidentifications (or coding/reporting errors) are present in some data sets.

26.1.9 Summary and future work

There is increased interest in the status of both species, and especially *D. intermedius,* in European seas (e.g. Garbett *et al*., 2021). The previous IUCN assessment for the species complex (Dulvy *et al*., 2006) considered a decline in geographic extent among the criteria used. However, given the separation of the two species and increased uncertainty with regards the historical distributions of the two species, more rigorous appraisal of historical information and examination of museum samples are required to inform on the overall distributions of the species.

In terms of historical studies, ichthyological accounts for the period approximately from 1837/1838 (when *D. intermedius* was described) until 1926 (when it was synonymised with *Dipturus batis*), may provide some relevant information. For example, Murie (1903) reported skate (as *Raia batis*) from the Outer Thames area, but noted that flapper skate (as *R. macrorhynchus*) had not been reported from that area. Similarly, Herdman and Dawson (1902) confirmed that blue skate (as *Raia batis*) was in the Irish Sea and, in relation to flapper skate (as *R. macrorhynchus*), noted that it had been reported by fishers from the area but that the authors had not seen any specimens of skate that they considered distinct from blue skate. Day (1880–1884) noted that flapper skate (as *R. macrorhynchus*) had also been observed at Plymouth and from Dublin Bay, but that data were limited. Such information would suggest that *D. batis* was the main species of the complex occurring in the Irish Sea (Division 7.a) and potentially the only species of the complex occurring in the southern North Sea (Division 4.c). Collation of other relevant accounts could potentially provide more information on the distributions of the two species.

Additionally, given that some parasites of elasmobranchs, particularly cestodes, can show a high degree of host-specificity, a critical review of published parasitological studies (e.g. Rees & Llewellyn, 1941; Williams, 1959; Manger, 1972; Kennedy and Williams, 1989; Benmeslem *et al*., 2019) could also usefully be considered.

Survey data are becoming increasingly available for each species within the common skate complex. However, they must be handled with care, as the accepted scientific name of common blue skate *Dipturus batis* (and also the accepted FAO code) can be confused with historical data, field identification guides produced prior to 2010 do not separate the two species, and identifications on surveys are not fully accurate. Consequently, improved and consistent identification is still required on trawl surveys. Concerning the potential for confusion regarding the name of common blue skate, it would be useful if the scientists in charge on surveys could ensure that more detailed comments confirming the occurrence of each of the species, and that reporting of *D. batis* indeed relates to common blue skate *D. batis*, rather than relating to species-complex. If the exact species is not known, data should be reported at the genus level (i.e. *Dipturus* spp., Aphia ID = 105762).

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Table 26.1. Distinguishing features of common blue skate *Dipturus batis* and flapper skate *Dipturus intermedius*. Adapted from Iglésias *et al.* (2010), with more recent data added where relevant (*).

Feature	Common blue skate	Flapper skate
Eye (iris colour)	Pale yellow	Dark olive-green
Eye-spots on pectoral fin	*"Blotch on wing with ocellus with dark centre surrounded by pale ring"*	*"Blotch of grouped pale spots"*
Lateral thorns on tail	Lateral thorns perpendicular	Lateral thorns project anteriorly (towards head)
Dentition	Teeth relatively narrower	Teeth relatively broader
Maximum length	143.2 (to at least 149 cm*)	228.8 cm
Length-at-maturity (female)	122.9 cm	197.5 cm
Length-at-maturity (male)	115 cm	185.5 cm

Table 26.2. Original description of *Raia flossada* Risso, 1826

Cette espèce, la plus remarquable de nos bords par sa grandeur, présente un corps épais, bombé au milieu, d'un gris cendré, parsemé de taches irrégulières blanches et noirâtres, couvert de petite aspérités qui le rendant âpre au toucher; tout le dessous est blanc, tacheté de points noirs; le museau est prolongé en pointe arrondie; les yeux sont proéminents, ovales oblongs, et ont l'iris blanchâtre, avec la prunelle bleue; les narines sont grandes, arquées; la bouche a beaucoup d'ampleur, et ses mâchoires sont munies dans leur milieu de onze rangées de dents coniques, aiguës et crochues, et seulement de chaque côté de sept rangées de dents un peu obtuses; les ouvertures branchiales sont linéaires; les nageoires ventrales sinueuses, à dix-huit rayons chacune; la queue est courte, épaisse, courbée, terminée au sommet, qui est tronqué, par deux nageoires oblongues; elle est bombée en dessus, aplatie en dessous, et munie de chaque côté de quarante-deux aiguillons crochus; la chair de cette raie est blanche et d'un goût fade. La femelle est aussi grosse que le mâle. Long. 1,200, enverg. 0,900. Séj. Grandes profondeurs. App. Avril, mai.
[*This species, the most remarkable of our borders by its size, has a thick body, rounded in the middle, of an ash grey, dotted with white and blackish irregular spots, covered with small denticles which make it harsh to the touch; all below is white, speckled with black dots; the snout is extended in a rounded point; the eyes are prominent, oblong oval, and have a whitish iris, with blue centre; the nostrils are large, arched; the mouth is very full, and its jaws are provided in their middle with eleven rows of conical, sharp, hooked teeth, and only on each side with seven rows of somewhat obtuse teeth; the gill openings are linear; sinuous ventral fins, eighteen rays each; the tail is short, thick, curved, terminating at the top, which is truncated, by two oblong fins; it is rounded above, flattened below, and provided on each side with forty-two hooked spines; the flesh of this ray is white and tasteless. The female is as big as the male. Length: 120 cm, width: 90 cm. Habitat: Great depths. Appearance: April May.*]

Table 26.3. Taxonomic units of the genus *Dipturus* occurring in the North-east Atlantic, including taxa considered in the present analyses. In the subsequent two tables, the FSS species codes have been used, as these better separate the two species from the complex. Information on the undescribed *Dipturus* sp. is provided in Ebert and Stehmann (2013).

Common name	Scientific name	Code (FSS)	Code (FAO)	AphiaID
Common skate complex	*Dipturus batis*-complex	SKT	RJB	-
Common blue skate	*Dipturus batis*	SKG	RJB	105869
Flapper skate	*Dipturus intermedius*	SKF	DRJ	711846
Long-nosed skate	*Dipturus oxyrinchus*	LNS	RJO	105872
Norwegian skate	*Dipturus nidarosiensis*	RNS	JAD	105871
Undescribed *Dipturus* sp.	*Dipturus* sp.	-	-	-
Unidentified *Dipturus* spp.	*Dipturus* spp.	-	-	105762

Table 26.4. Summary of catch records for *Dipturus* spp. held on CEFAS' database in relation to process code (CO = counted only; MO = measured only; OB = observed; WC = weighed and counted; WM = weighed and measured; WO = weighed only) and survey series for the years 1901–2021. These data refer to station records and not the numbers of individual animals caught (see below). Surveys with no records of either of the case study species not included. Current trawl survey monitoring programmes indicated*. See Table 26.3 for list of species codes, including those used on FSS (shown here) and the corresponding FAO codes.

Survey series	Process code	LNS	RNS	SKF	SKG	SKT	Total
ARCTIC	CO					40	40
	OB					15	15
	WO					2	2
DCRDC	WM					24	24
ELASMOS[1]	MO			16	158		174
HISTORIC	CO	4	2			354	360
	MO					277	277
	OB	15				61	76
	WC					32	32
	WM					16	16
	WO					11	11
HISTORWEST	CO	2			1	72	75
	MO					99	99
	OB					3	3
	WC					1	1
	WO					2	2
IBTS3E*[2]	MO					1	1
	WM	2		6	1	13	22
IBTS4E	WM					2	2
MEMFISH	WM					1	1
NSGFS	OB	1				2	3
	WM	6				10	16
Q1SWBEAM*[3]	OB					1	1
	WM			1	65	111	177
Q1SWOTTER	WM			5	63	2	70
Q4SWIBTS	WM					21	21
WCGFS	WM	6	2			68	76
YFS	MO					2	2
Total		36	4	28	288	1243	1599

[1] Data collected on chartered commercial fishing vessel

[2] This survey relates to NS-IBTS-Q3

[3] This survey may also be referred to as 'Q1SWECOS', 'BTS-UK-Q1' or 'UK-Q1SWBeam' in other ICES-related documents.

Table 26.5. Summary of number of measured *Dipturus* spp. held on CEFAS' database by survey series (1901–2021). Current trawl survey monitoring programmes indicated*. See Table 26.3 for list of species codes, including those used on FSS (shown here) and the corresponding FAO codes.

Survey series	LNS	RNS	SKF	SKG	SKT	Total
ELASMOS	–	–	30	2416	–	2446
HISTORIC	–	–	–	–	692	692
*Q1SWBEAM	–	–	1	85	125	211
Q1SWOTTER	–	–	7	195	3	205
HISTORWEST	–	–	–	–	195	195
WCGFS	7	2	–	–	83	92
DCRDC	–	–	–	–	31	31
*IBTS3E	2	–	10	1	16	29
Q4SWIBTS	–	–	–	–	27	27
NSGFS	7	–	–	–	10	17
IBTS4E	–	–	–	–	2	2
YFS	–	–	–	–	2	2
MEMFISH	–	–	–	–	1	1
ARCTIC	–	–	–	–	–	0
Total	16	2	48	2697	1187	3950

Table 26.6. Length-weight parameters for members of the common skate complex, including earlier published studies by sex (M: Male; F: Female; C: Sexes combined).

Species	Sex	N	L_T (cm)	Weight (g)	a	B	r2	Source
Total weight (W_T)								
Dipturus batis-complex	C	8	18–49 D_W	88–1886	0.0108	3.0787	–	Coull *et al.* (1988)[5]
	C	32	52–130	700–15960	0.0010	3.391	0.986	Rosa *et al.* (2006)[3]
	F	32	19–135	–	0.0026	3.222	0.99	McCully *et al.* (2012)
	M	30	20–118	–	0.0041	3.123	0.95	
	C	46	19–131	36–13940	0.0038	3.1201	0.996	Silva *et al.* (2013)
	C	37	9.5–210.5[2]	–	0.00740	2.953	0.984	Wilhelms (2013)
	C [1]	140	18–200	26–80000[4]	0.0032	3.1679	0.980	This study
Dipturus batis	C	334	18–136	24–15770	0.003	3.1723	0.996	This study
	F		167	-	0.0024	3.2034	0.996	Barreau *et al.* (2016)
	M		196	-	0.0025	3.192	0.997	
Dipturus intermedius	C	19	34–170	170–33280	0.0017	3.2781	0.998	This study
Gutted weight (W_T)								
Dipturus batis	F	175	–	–	0.0026	3.1555	0.996	Barreau *et al.* (2016)
	M	197	–	–	0.0025	3.1718	0.997	
Dipturus intermedius	F	45	–	–	0.0011	3.3236	0.995	
	M	56	–	–	0.0006	3.4453	0.986	

[1] Includes only data where specimens were not identified to species-specific level.
[2] Minimum size given (9.5 cm) is less than the length-at-hatching.
[3] Data from the Azores, and so there is potential uncertainty in species.
[4] Maximum weight may be underestimated, as the Electronic Data Capture (EDC) system originally had a maximum weight of 80 kg.
[5] Values based on disc width (D_W) and not total length.

Table 26.7. Number of individual *Dipturus* spp. collected during Research Vessels surveys between 2010 and 2020, as reported on DATRAS. Data for the various species names used derived from the SpecCode field.

Species	Survey	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
Dipturus spp.	NS-IBTS	0	0	0	0	0	0	1	2	0	0	0	3
	SP-PORC	0	0	4	0	0	0	0	0	0	0	0	4
	NS-IBTS	2	2	1	0	1	2	0	0	0	0	0	8
Dipturus batis complex	BTS	0	0	2	0	1	1	18	56	35	31	1	145
	BTS-VIII	0	0	0	0	0	0	0	0	1	0	0	1
	EVHOE	1	0	0	0	0	0	0	0	5	0	0	6
	IE-IGFS	0	2	2	1	27	0	0	0	0	0	0	32
	NIGFS	0	0	0	0	1	0	0	0	0	0	1	2
	NS-IBTS	5	11	16	3	0	0	0	0	0	1	1	37
	ROCKALL	0	0	20	0	0	0	0	0	0	0	0	20
	SP-PORC	0	5	3	17	0	48	0	0	39	0	6	118
	SWC-IBTS	36	29	116	0	0	9	0	0	0	0	0	190
Dipturus batis (*= D.* cf. *flossada*)	EVHOE	0	10	7	16	12	19	25	0	84	84	99	356
	IE-IGFS	0	0	0	0	0	34	47	11	25	53	34	204
	NS-IBTS	0	0	0	2	3	4	2	2	8	6	11	38
	ROCKALL	0	6	0	29	62	34	67	61	85	98	61	503
	SWC-IBTS	0	0	0	0	4	0	26	14	17	10	24	95
Dipturus intermedius	EVHOE	0	1	0	0	1	1	2	0	3	4	5	17
	IE-IGFS	0	20	18	19	19	20	22	50	63	37	19	287
	NS-IBTS	0	0	0	15	10	7	16	19	17	26	19	129
	ROCKALL	0	10	0	0	0	0	0	0	0	0	0	10
	SWC-IBTS	0	31	0	74	165	52	131	151	94	151	116	965
Dipturus oxyrinchus	IE-IGFS	0	0	0	0	0	0	0	0	0	0	2	2
	MEDITS	0	0	68	72	65	69	0	0	0	0	0	274
	NS-IBTS	0	0	0	0	0	0	0	0	0	2	0	2
	PT-IBTS	0	0	0	0	2	0	0	0	0	0	0	2
	ROCKALL	0	4	2	3	5	8	0	6	3	2	2	35
	SP-NORTH	0	0	0	0	0	0	1	0	1	0	2	4
Dipturus nidarosiensis	ROCKALL	0	0	0	0	0	0	4	0	0	0	0	4
	SP-NORTH	0	0	0	0	0	0	0	2	0	0	0	2
	SP-PORC	0	1	5	4	0	30	0	0	5	0	5	50

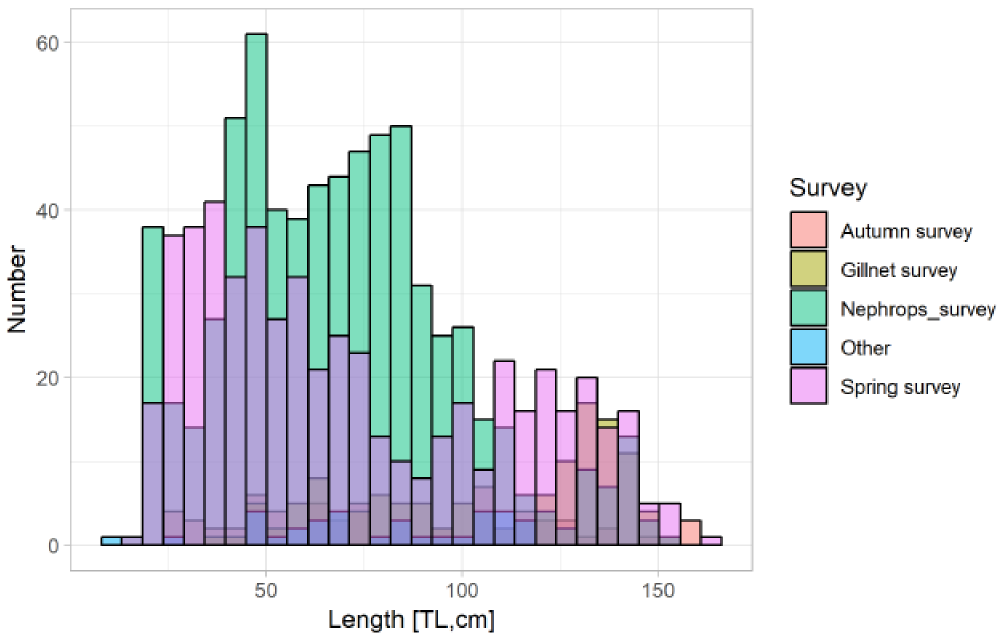

Figure 26.1. Length-frequency of 'common skate' recorded in various Icelandic surveys. The near absence of large individuals would be indicative of *Dipturus batis* being the main species present.

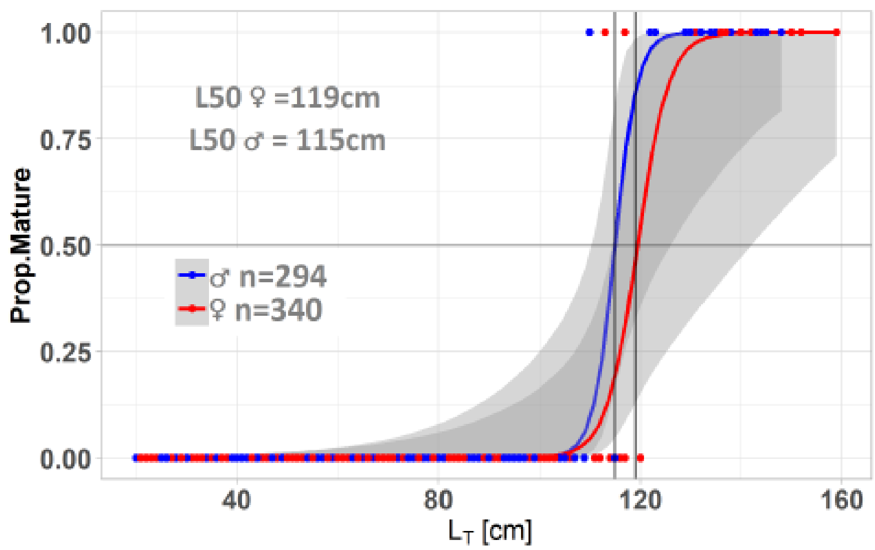

Figure 26.2. Length-at-maturity of 'common skate' recorded in Icelandic surveys. The estimated lengths-at-maturity are consistent with those values provided by Iglésias *et al.* (2010) for *Dipturus* cf. *flossada*, thus being indicative of *Dipturus batis.*

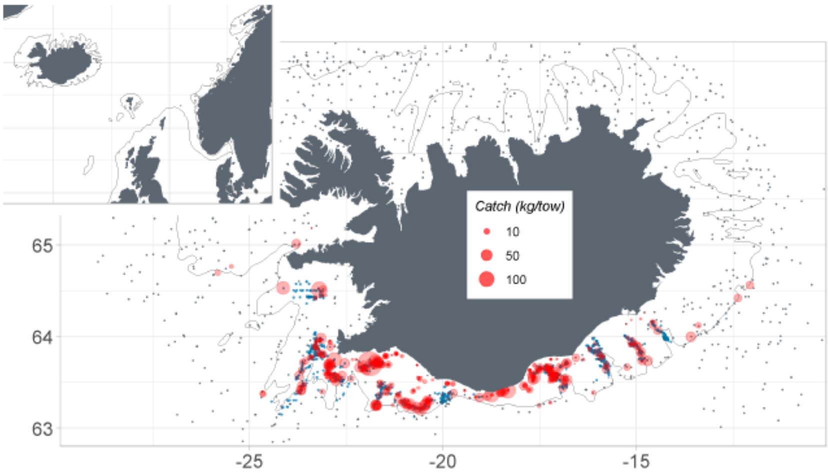

Figure 26.3. Distribution of common skate complex (presumed to be *D. batis*) in Icelandic waters. Grey points: Stations sampled in spring and autumn bottom trawl surveys each year. Red circles indicate the occurrence and catch rates of *D. batis*, with blue circles using data from a *Nephrops* survey (2002–2018).

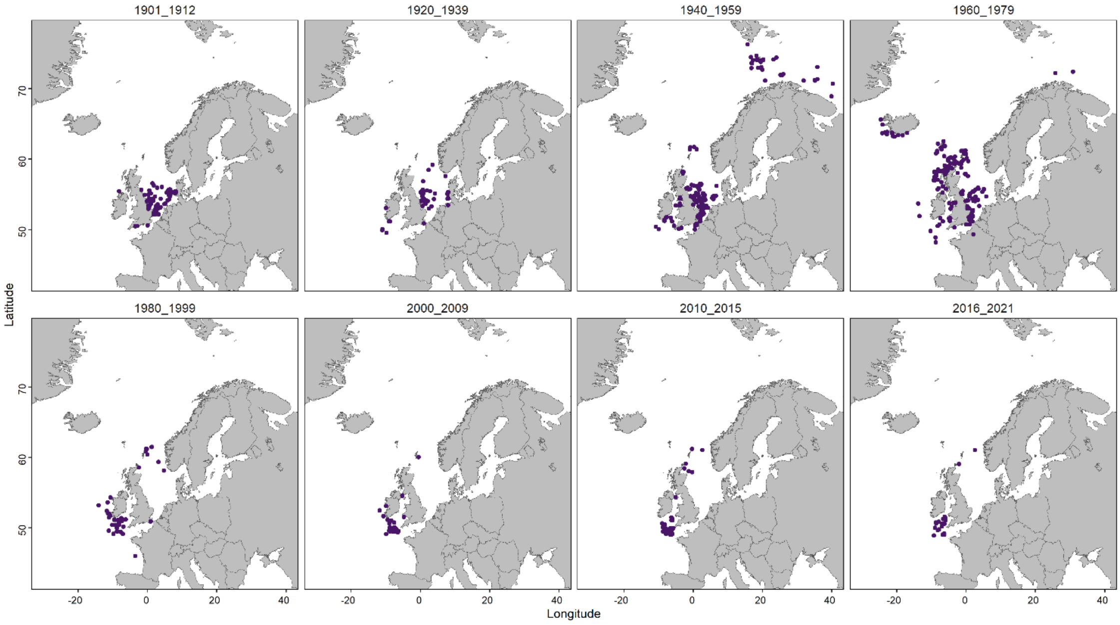

Figure 26.4. Recorded presence of common skate-complex by time period in scientific trawl surveys(?). Note: Latitude and longitude used from hauling positions. Only shown records where specimens were not identified and/or allocated to particular species. Hauls with no records are not shown, and so broadscale changes in distribution over time are not indicated.

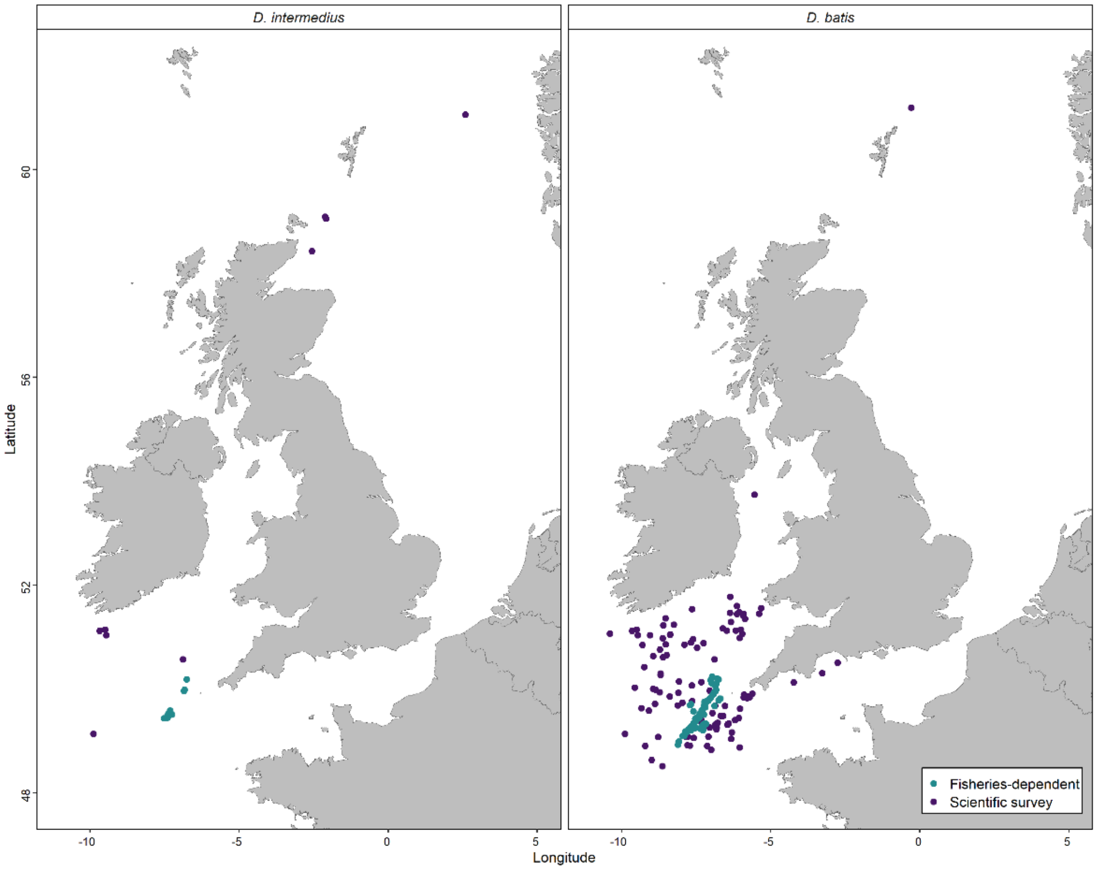

Figure 26.5. Recorded presence of common blue skate *D. batis* and flapper skate *D. intermedius* by survey. Note: Latitude and longitude used from hauling positions.

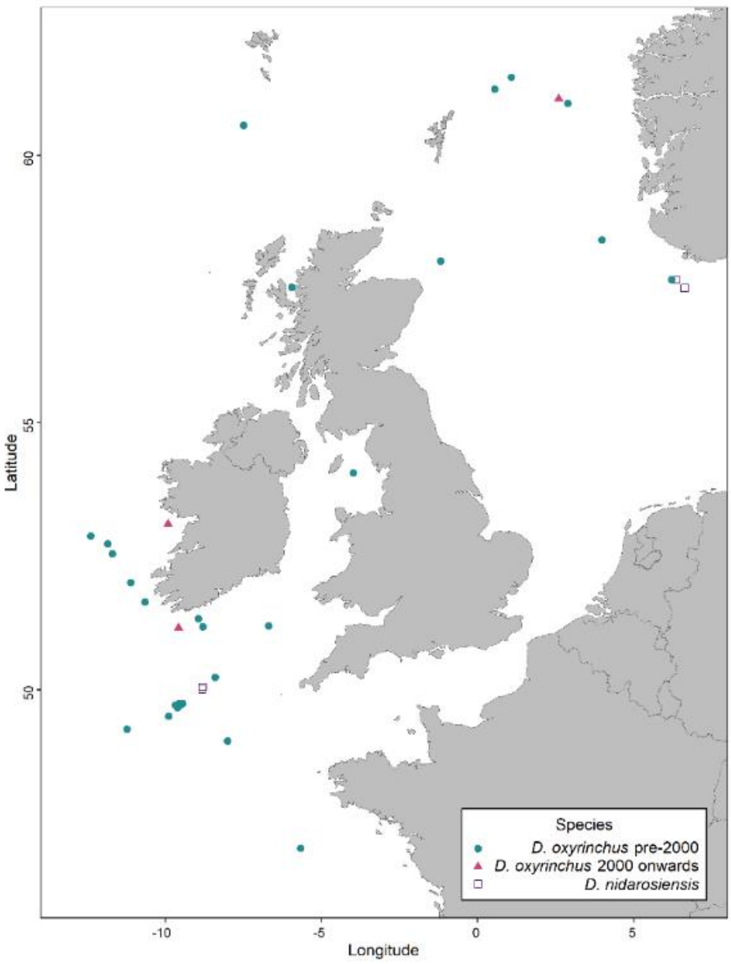

Figure 26.6. Recorded presence of long-nosed skate *D. oxyrinchus* (pre-2000 and 2000 onwards) and Norwegian skate *D. nidarosiensis*. Note: Latitude and longitude used from hauling positions. These two species have only occurred on scientific surveys (fisheries-independent). Note: Given that most of these records were recorded prior to the revised separation of the common skate complex, these data may include misidentified flapper skate. Hence, these data should be interpreted with caution.

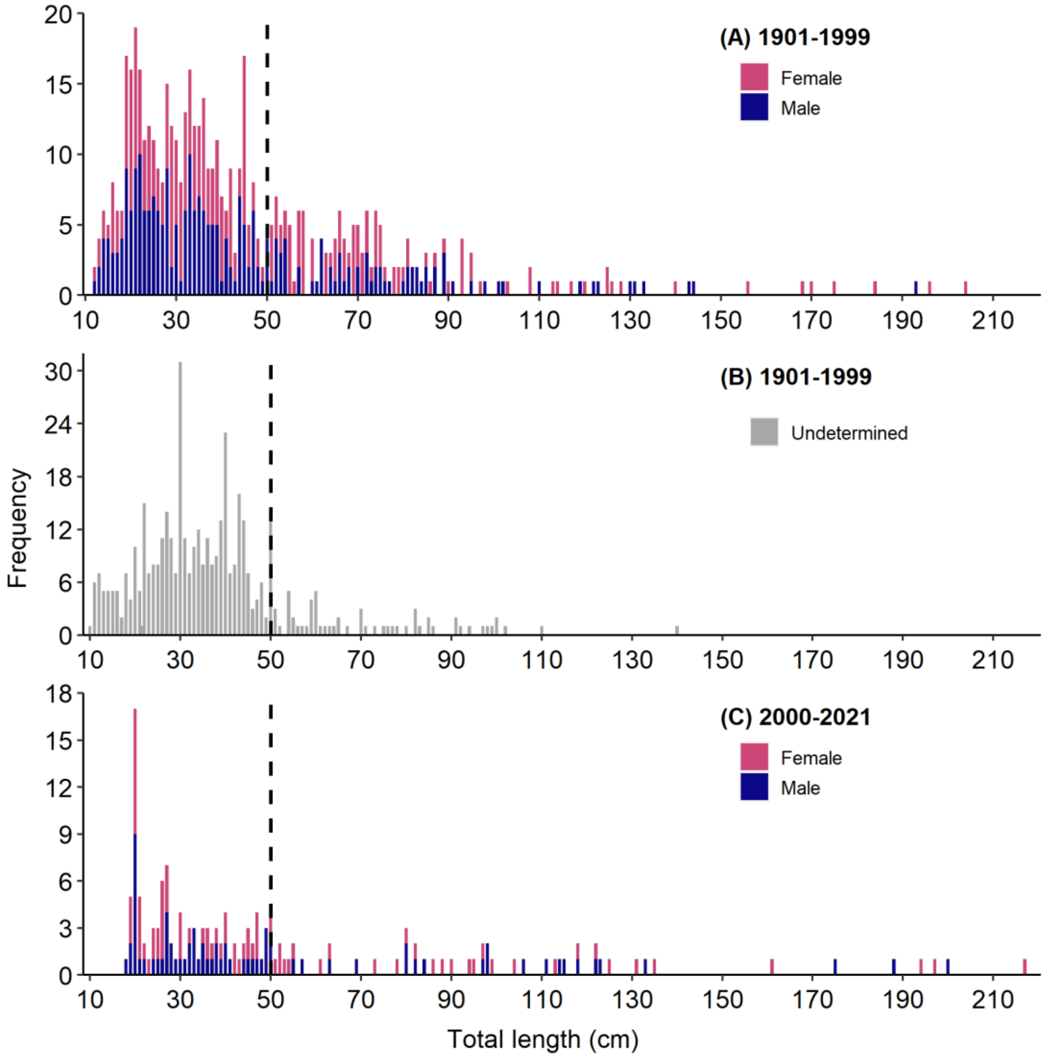

Figure 26.7. Length frequency distribution for common skate-complex *Dipturus batis*-complex by sex for (A) 1901–1999 (Females, n = 291, 12–204 cm L_T; Males n = 258, 12–193 cm L_T), (B) 1901–1999 (Undetermined, n = 425, 10–140 cm L_T) and (C) 2000–2021 (Females, n = 83, 19–217 cm L_T; Males, n = 74, 18–200 cm L_T). Note: Dashed line represents length assumed for 'exploitable biomass' at 50 cm L_T. Data for common-skate complex only considered records where specimens were not identified and/or allocated to species-specific, these were only reported during scientific surveys. Different y-axis to avoid data to be skewed.

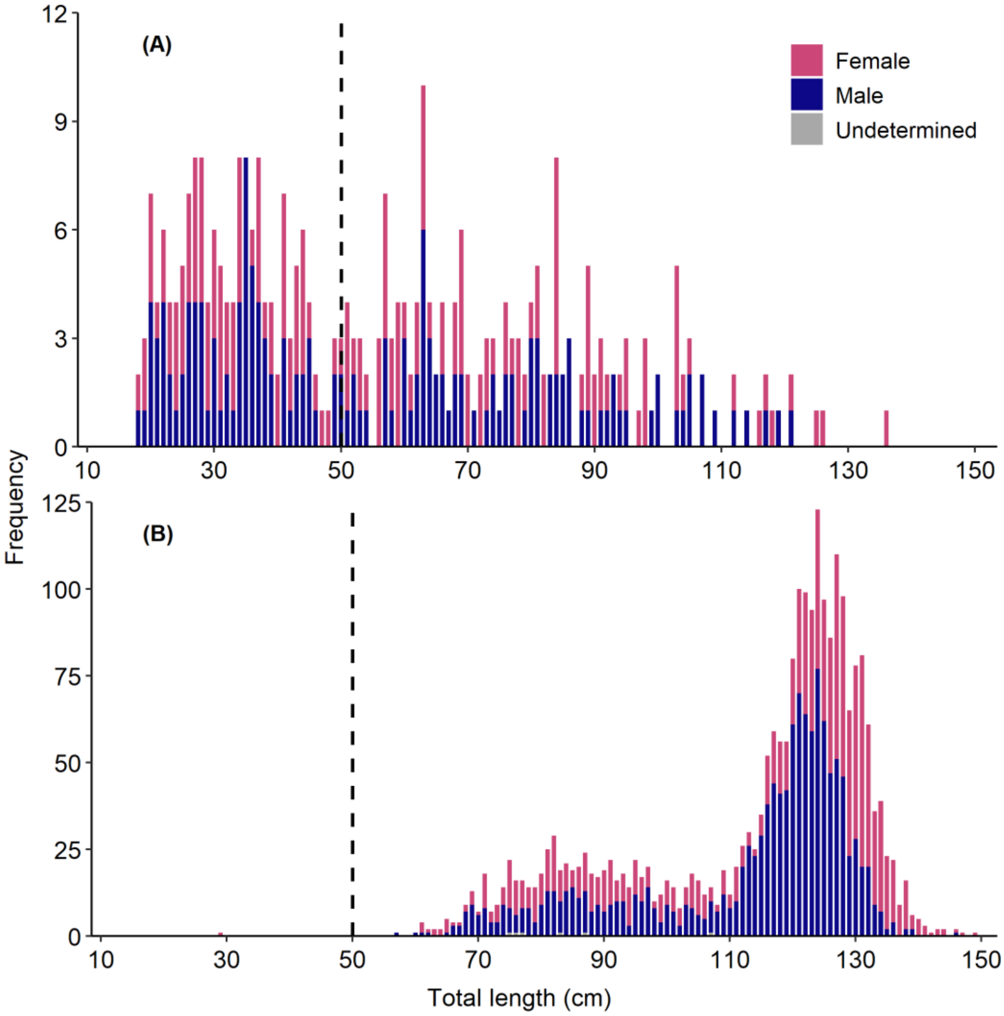

Figure 26.8. Length frequency distribution for common blue skate *D. batis* by sex and survey (A) scientific survey (Females, n = 174, 18–136 cm L_T; Males, n = 161, 18–121 cm L_T) and (B) fisheries-dependent survey (Females, n = 1,113, 29–149 cm L_T; Males, n = 1,297, 57–146 cm L_T; Undetermined, n = 6, 75–107 cm L_T). Note: Dashed line represents length assumed for 'exploitable biomass' at 50 cm L_T. Different y-axis to avoid data to be skewed.

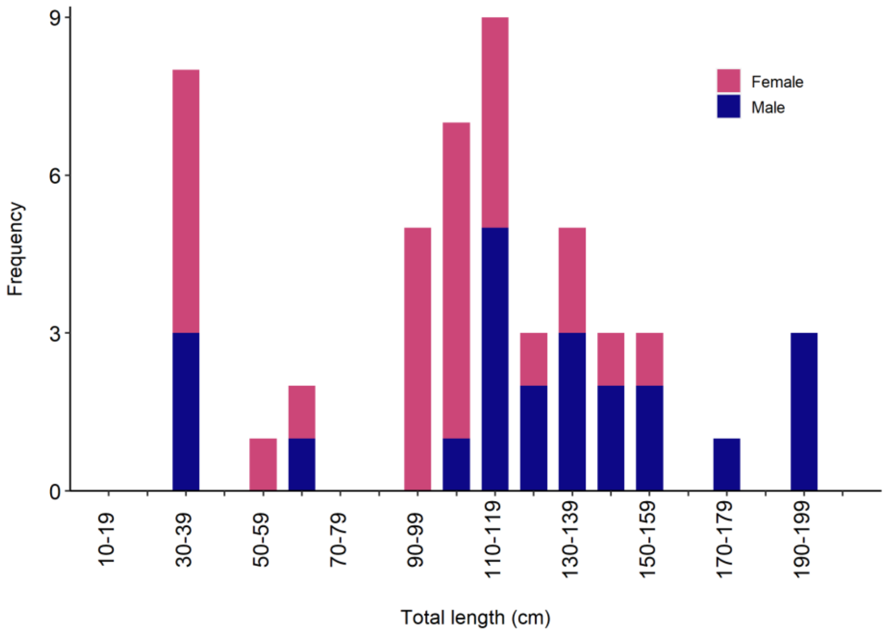

Figure 26.9. Length frequency distribution for flapper skate *D. intermedius* by sex (Females: n = 27, 34–154 cm L_T; Males: n = 23, 34–195 cm L_T). Note: Data aggregated across surveys due to limited available records and in 10 cm bins.

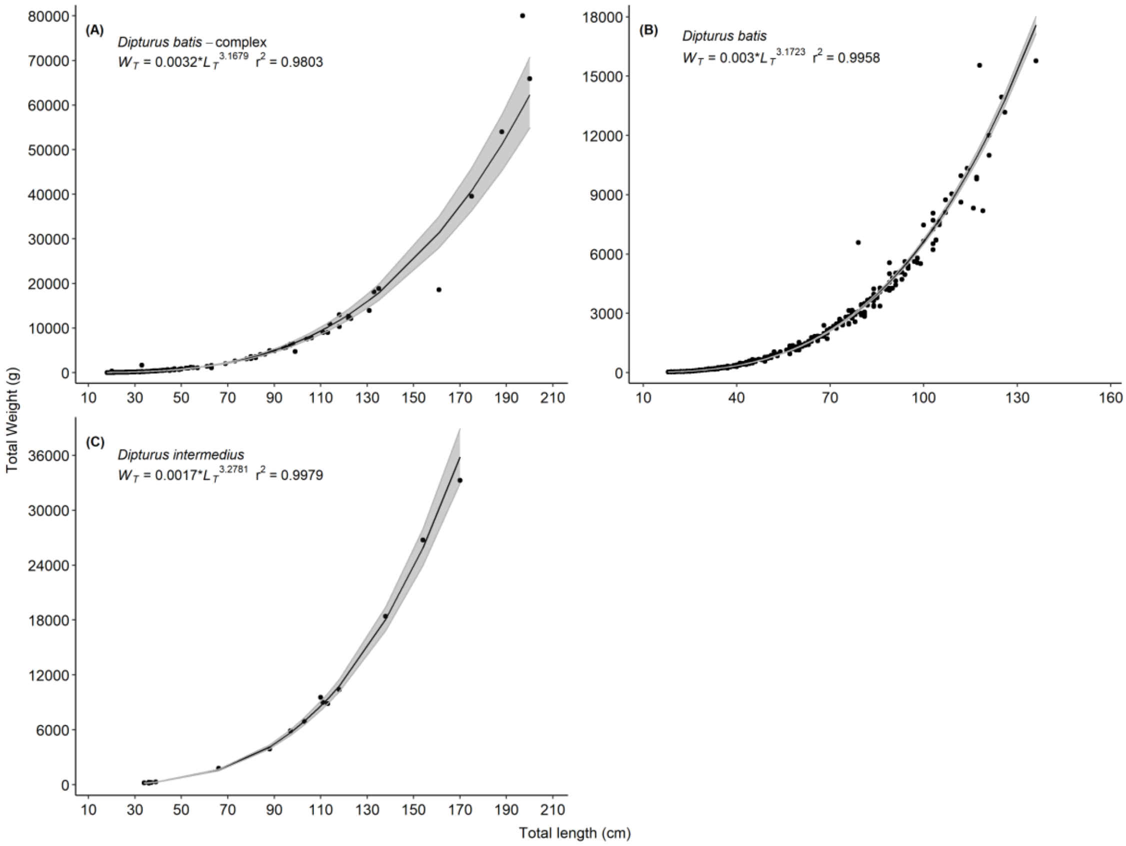

Figure 26.10. Relationships between total weight (W_T, g) and total length (L_T, cm) across years and surveys for (A) common skate-complex (n = 140), (B) common blue skate *D. batis* (n = 334) and (C) flapper skate *D. intermedius* (n = 19). Note: Data for common-skate complex only considered records where specimens were not identified and/or allocated to species-specific (A). Different axes used to avoid data being skewed. See also Table 26.6.

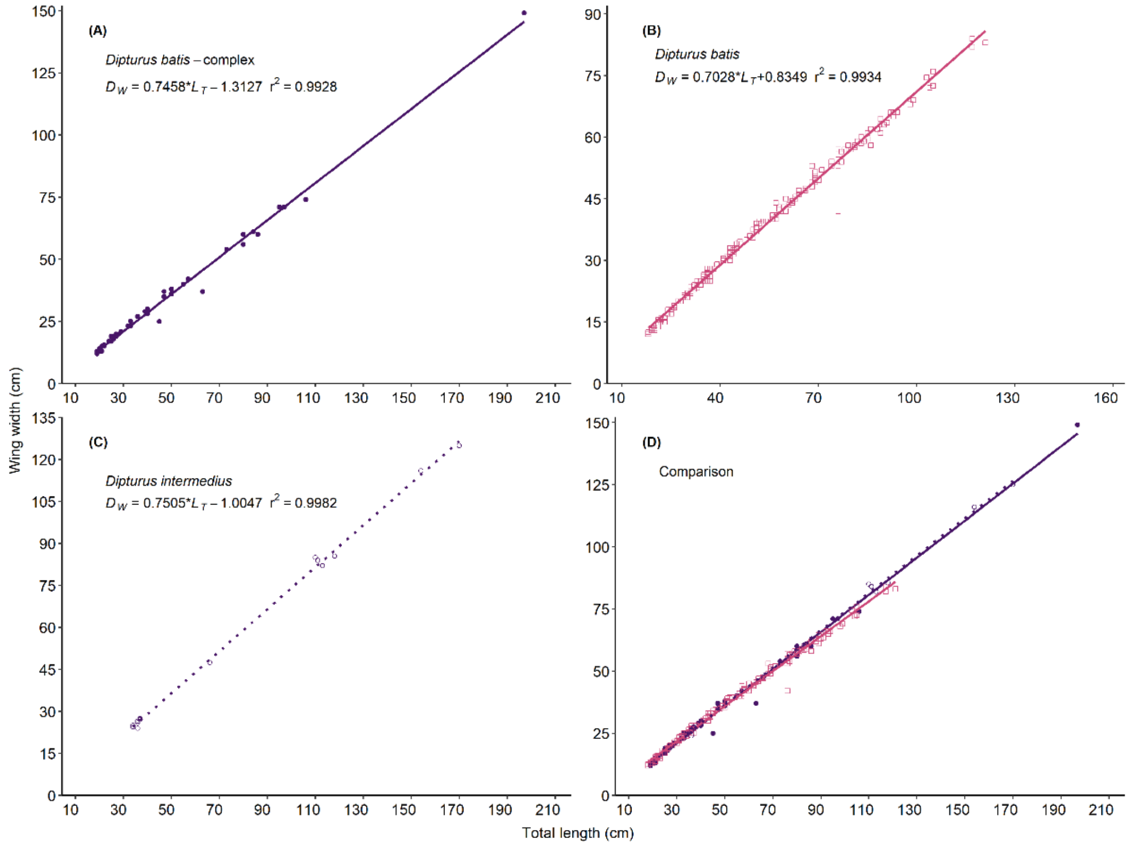

Figure 26.11. Total length (L_T, cm) to wing width (D_W, cm) across years and surveys for (A) common skate-complex (n = 53), (B) common blue skate *D. batis* (n = 204), (C) flapper skate *D. intermedius* (n = 14) and (D) comparison of relationships. Note: Data for common-skate complex only considered records where specimens were not identified and/or allocated to species-specific (A). Different axis to avoid data to be skewed.

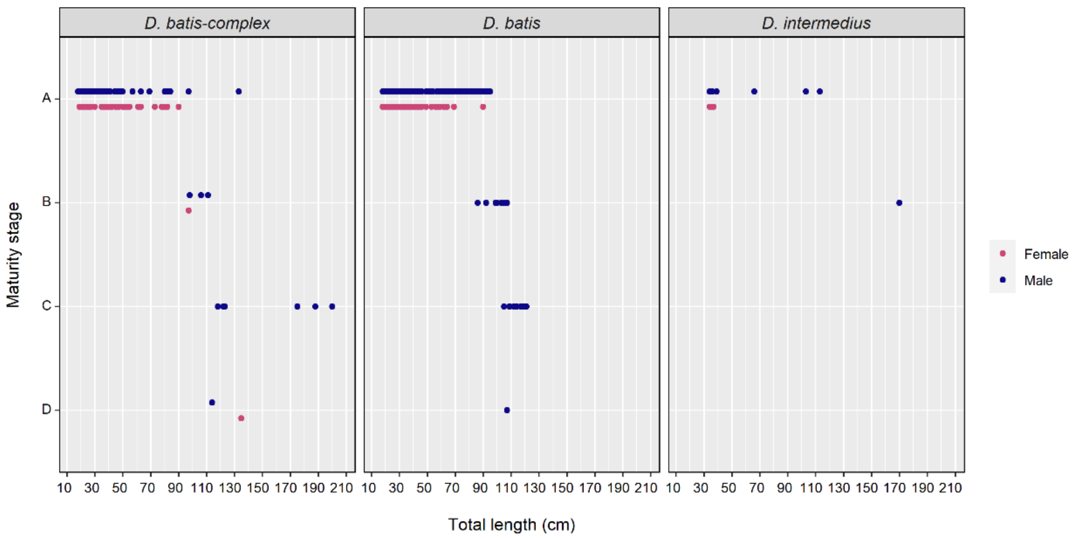

Figure 26.12. Maturity stage by sex and total length (L_T) (A) common skate-complex *D.* batis-complex (n = 53), (B) common blue skate *D. batis* (n = 204) and (C) flapper skate *D.* intermedius (n = 14). Note: Data for common-skate complex only considered records where specimens were not identified and/or allocated to a specific species. Maturity stages: A (Immature), B (Maturing), C (Mature) and D (Active). Other species not shown as limited data but describe in text.

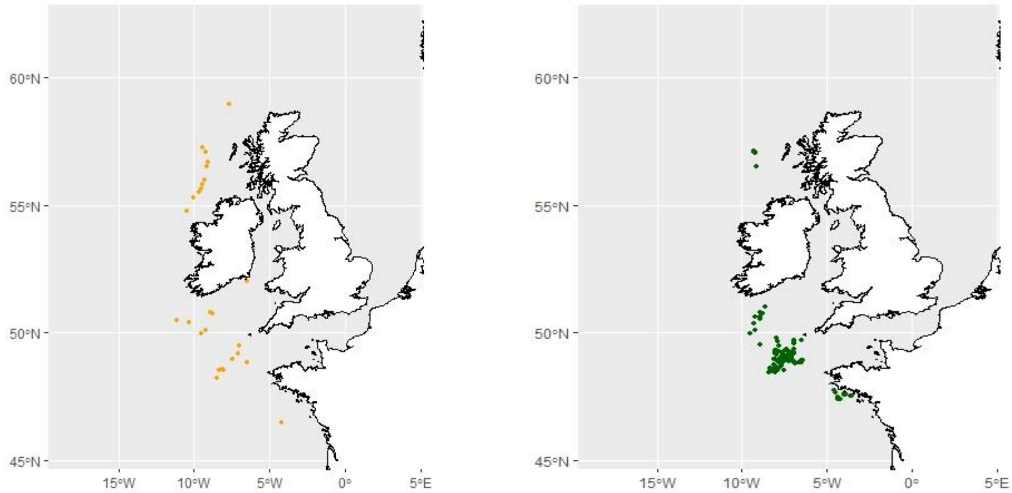

Figure 26.13. Observed occurrence (2006–2016) of flapper skate *Dipturus intermedius* (left, orange circles; n = 95) and common blue skate *Dipturus batis* (right, green circles; n = 1378).

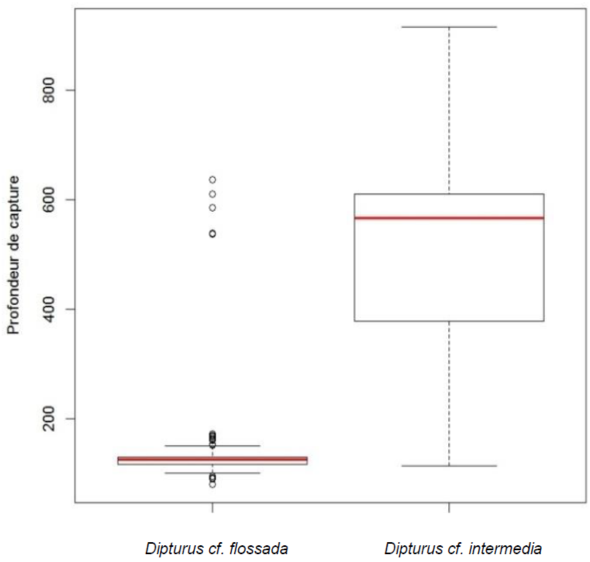

Figure 26.14. Boxplot on depth of capture for *Dipturus batis* (here labelled as "*D. cf. flossada*"; n = 1332) and *D. intermedius* (here labelled as ''*D. cf. intermedia*''; n = 64) recorded during onboard fishing vessels observation program ''POCHETEAU'' including one trip on the edge of the North-west Scotland shelf (2007) and six trips (2013–2015) on the continental shelf of the Celtic Sea. Red line is the median depth of catch. Source: Barreau *et al.* (2016).

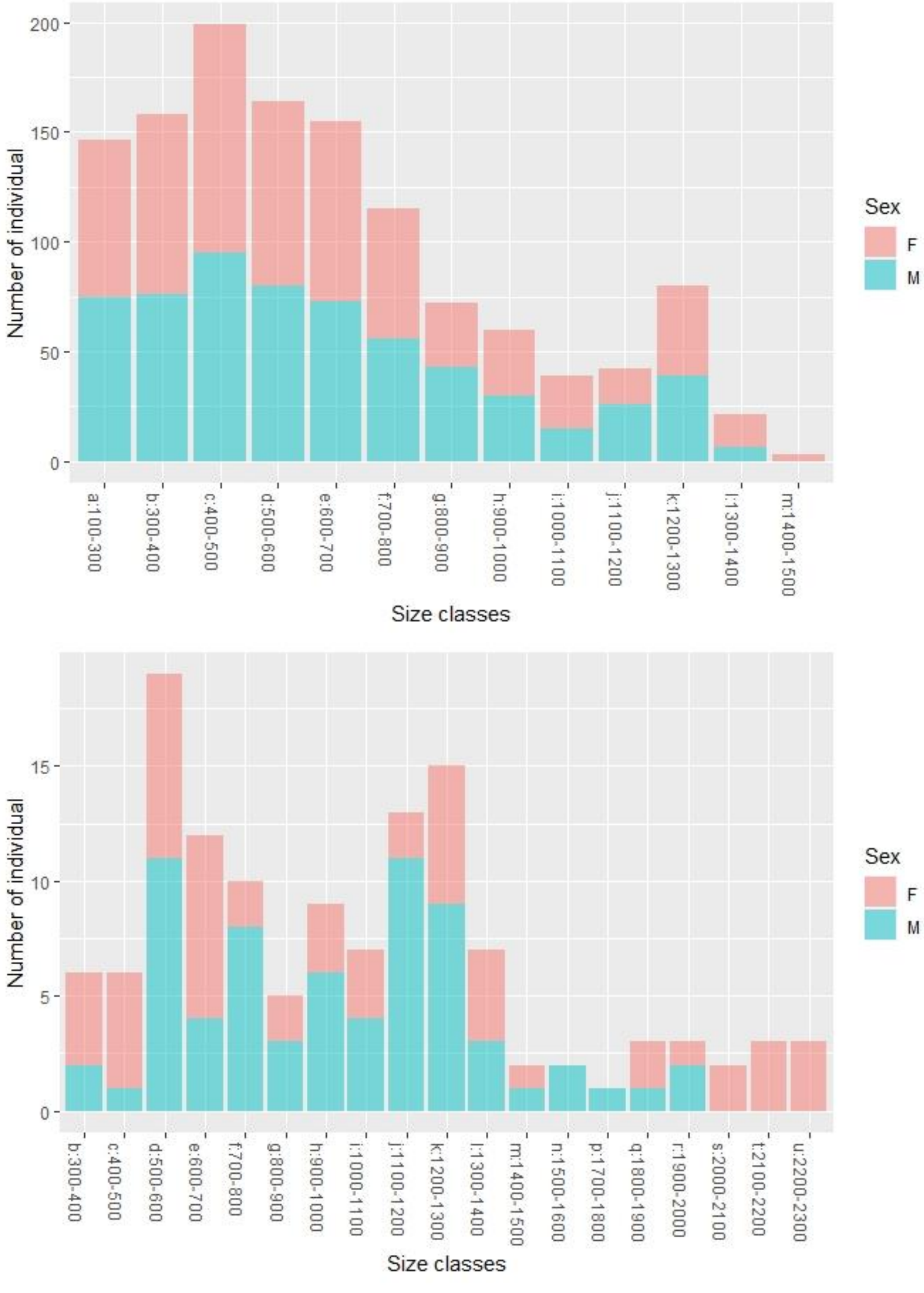

Figure 26.15. Length-frequency distributions (in 10 cm size classes) by sex (red: female; blue: male) of common blue skate *Dipturus batis* (top; n = 1254) and flapper skate *D. intermedius* (bottom; n = 128) observed during the Pocheteau project (2013–2015). Source: Barreau *et al.* (2016).

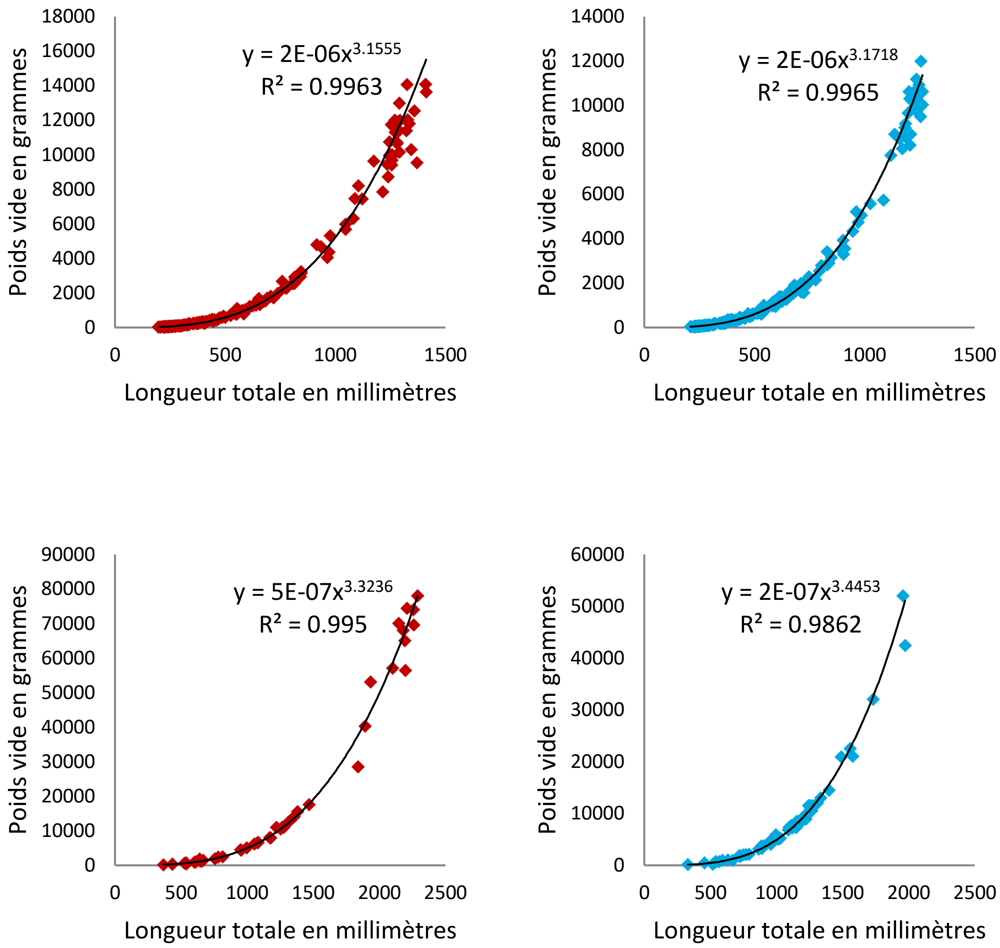

Figure 26.16. Length-gutted weight relationships per sex based for common blue skate *Dipturus batis* (top left: female, n = 175; top right: male, n = 197) and flapper skate *Dipturus intermedius* (bottom left: female, n = 45; bottom right: male, n = 56). Source: Barreau *et al.* (2016). See also Table 26.6.

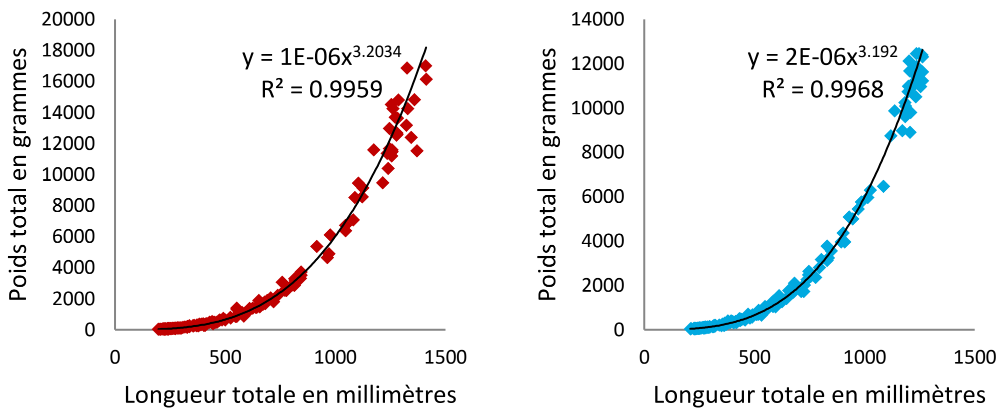

Figure 26.17. Length-total weight relationship per sex for common blue skate *Dipturus batis* (left: female, n = 167; right: male, n = 196). Source: Barreau *et al.* (2016). See also Table 26.6.

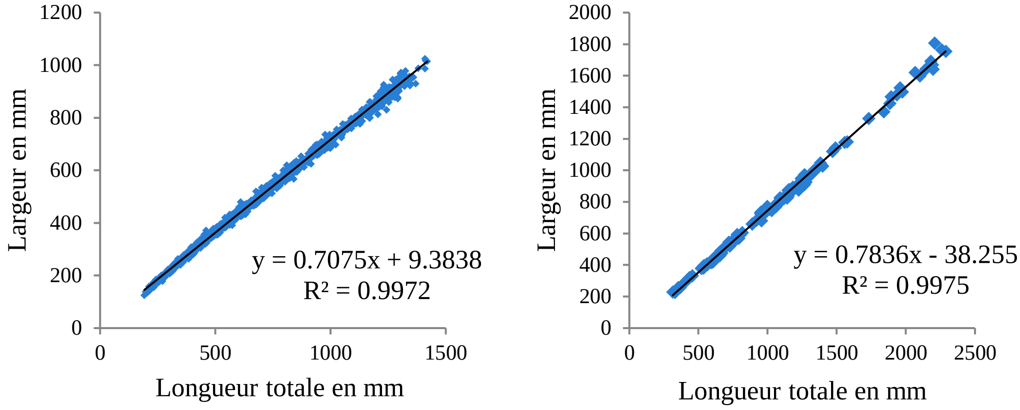

Figure 26.18. Relationship between disc width (largeur, mm) and total length (longueur total, mm), as defined by $y = ax + b$ for common blue skate *D. batis* (left, n = 1374) and flapper skate *D. intermedius* (right, n = 115). Source: Barreau *et al.* (2016).

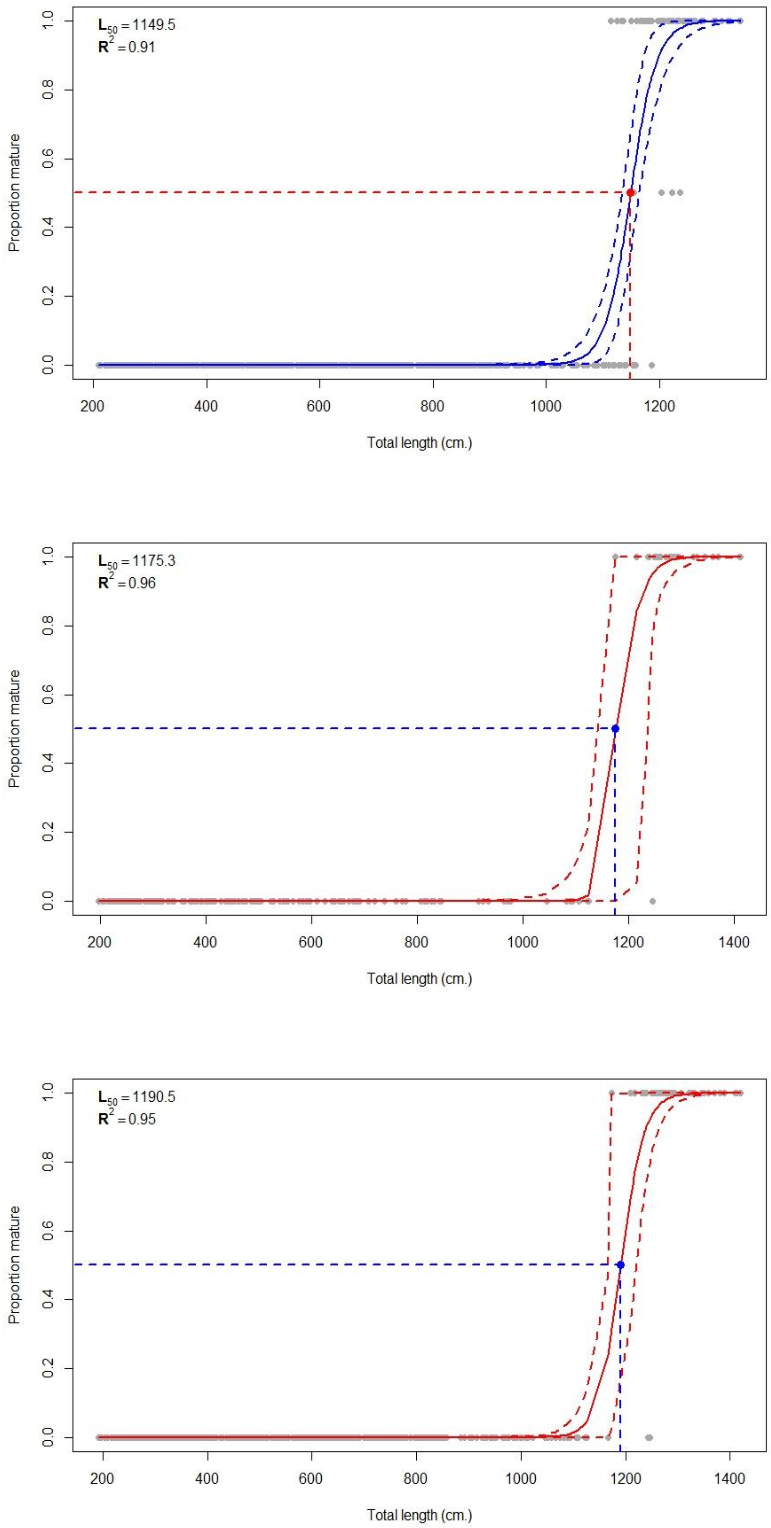

Figure 26.19. Maturity ogives for common blue skate *Dipturus batis* for males (top; n = 756; L_{50} = 114.95 cm), females (centre; n = 184; L50 = 117.53 cm, based on dissected specimens) and females (bottom; n = 694; L_{50} = 119.05 cm, based on the assumption that all females <90 cm are immature and that female caught alive but not dissected were mature if a flaccid cloaca was observed).

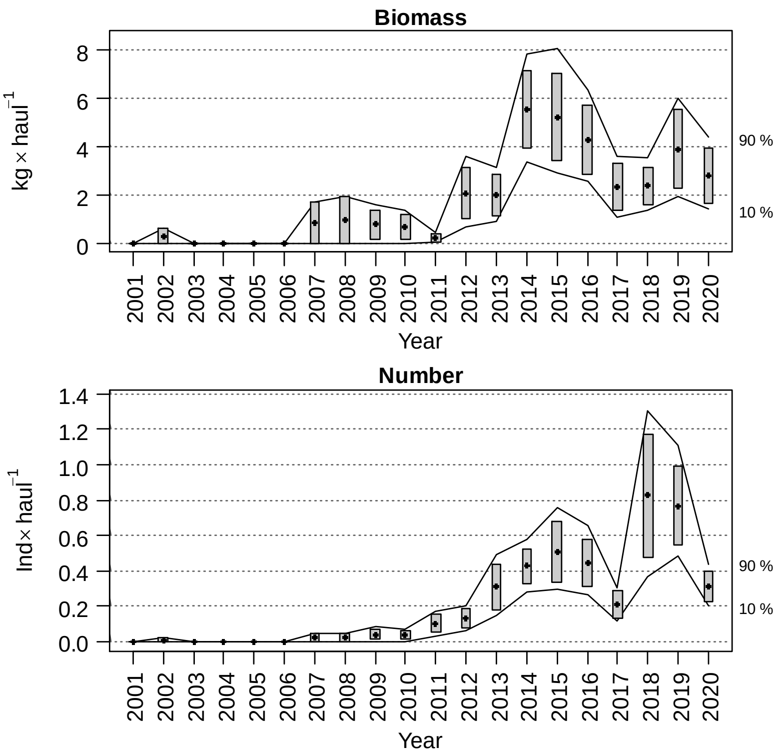

Figure 26.20. Temporal changes (2001–2020) in the biomass and abundance indices of *Dipturus* spp. during the Porcupine Bank survey. Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000).

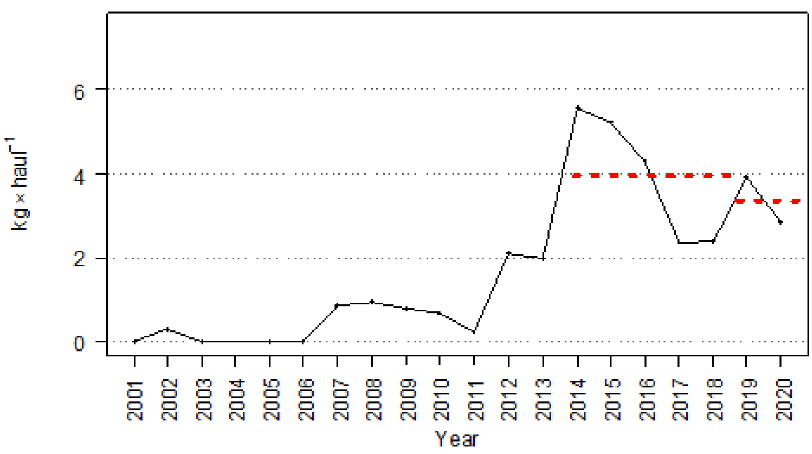

Figure 26.21. Temporal change in the biomass index for *Dipturus* spp., as recorded during the Porcupine Bank survey (2001–2020). Dotted lines compare the mean stratified biomass in the last two years with the five previous years.

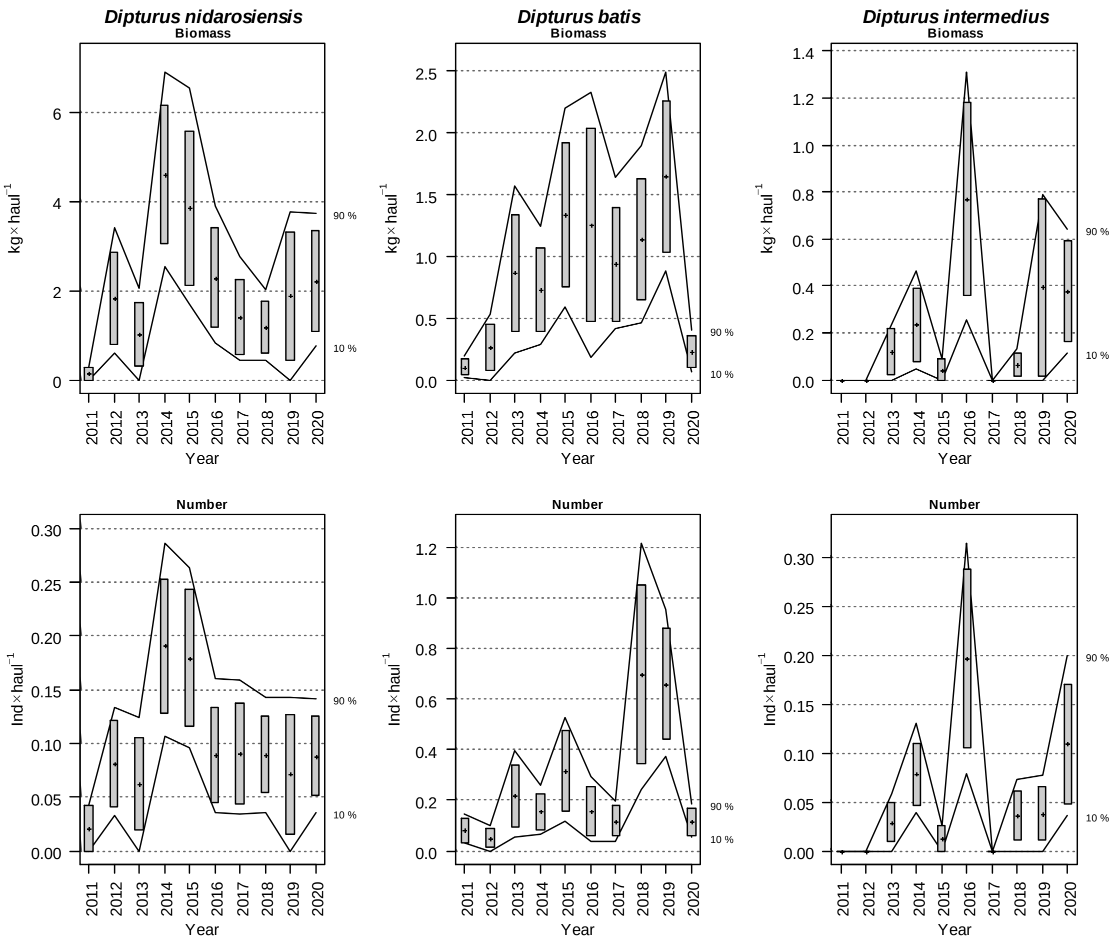

Figure 26.22. Temporal changes in the biomass and abundance indices of *Dipturus nidarosiensis, D. batis* and *D. intermedius* as recorded in the Porcupine Bank survey (2011–2020; species-specific data available). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000).

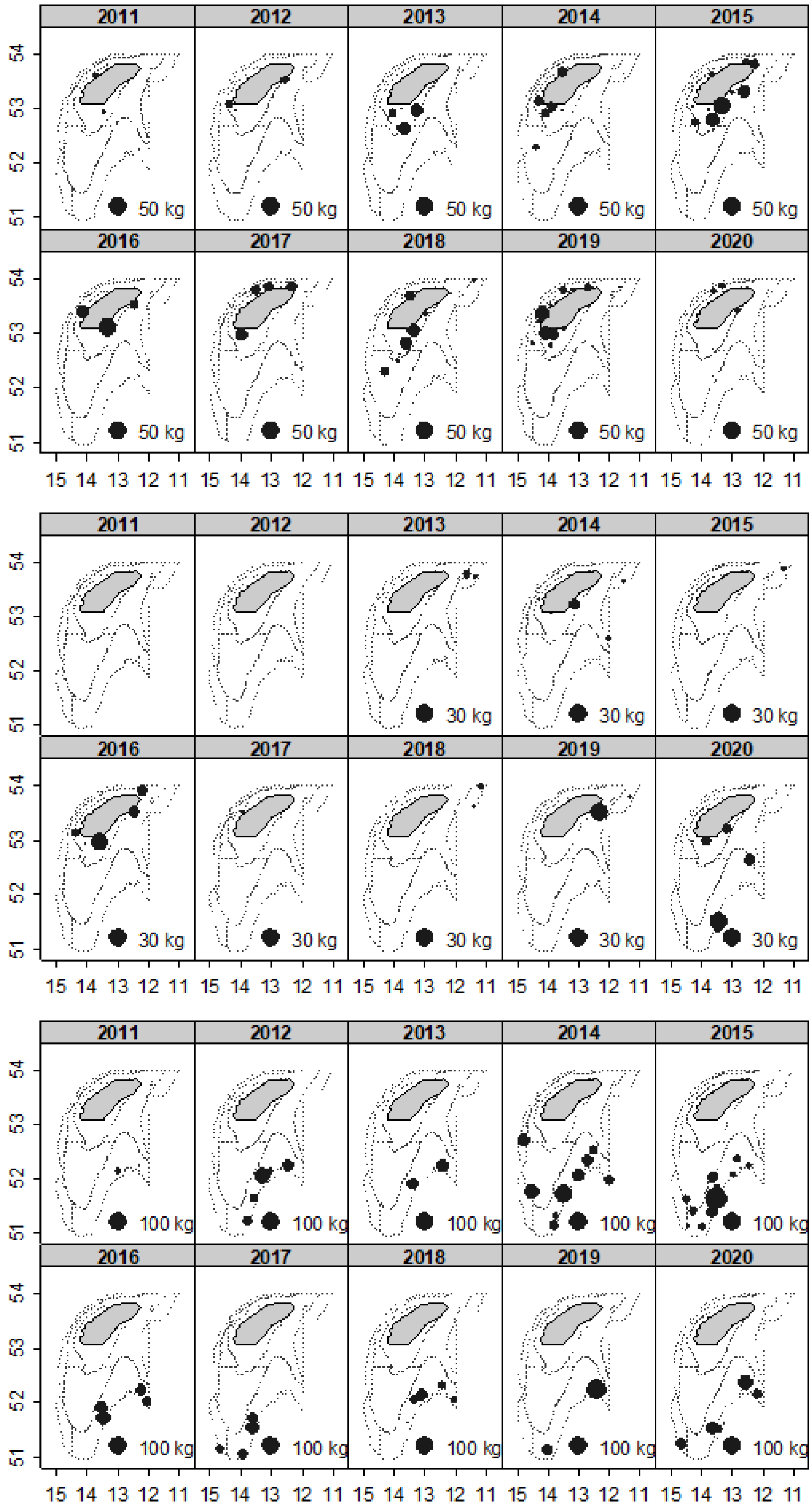

Figure 26.23. Geographic distribution and catch rates (kg.haul^{-1}) of *Dipturus batis* (top), *D. intermedius* (centre) and *D. nidarosiensis* (bottom) during Spanish surveys on the Porcupine Bank (2011–2020).

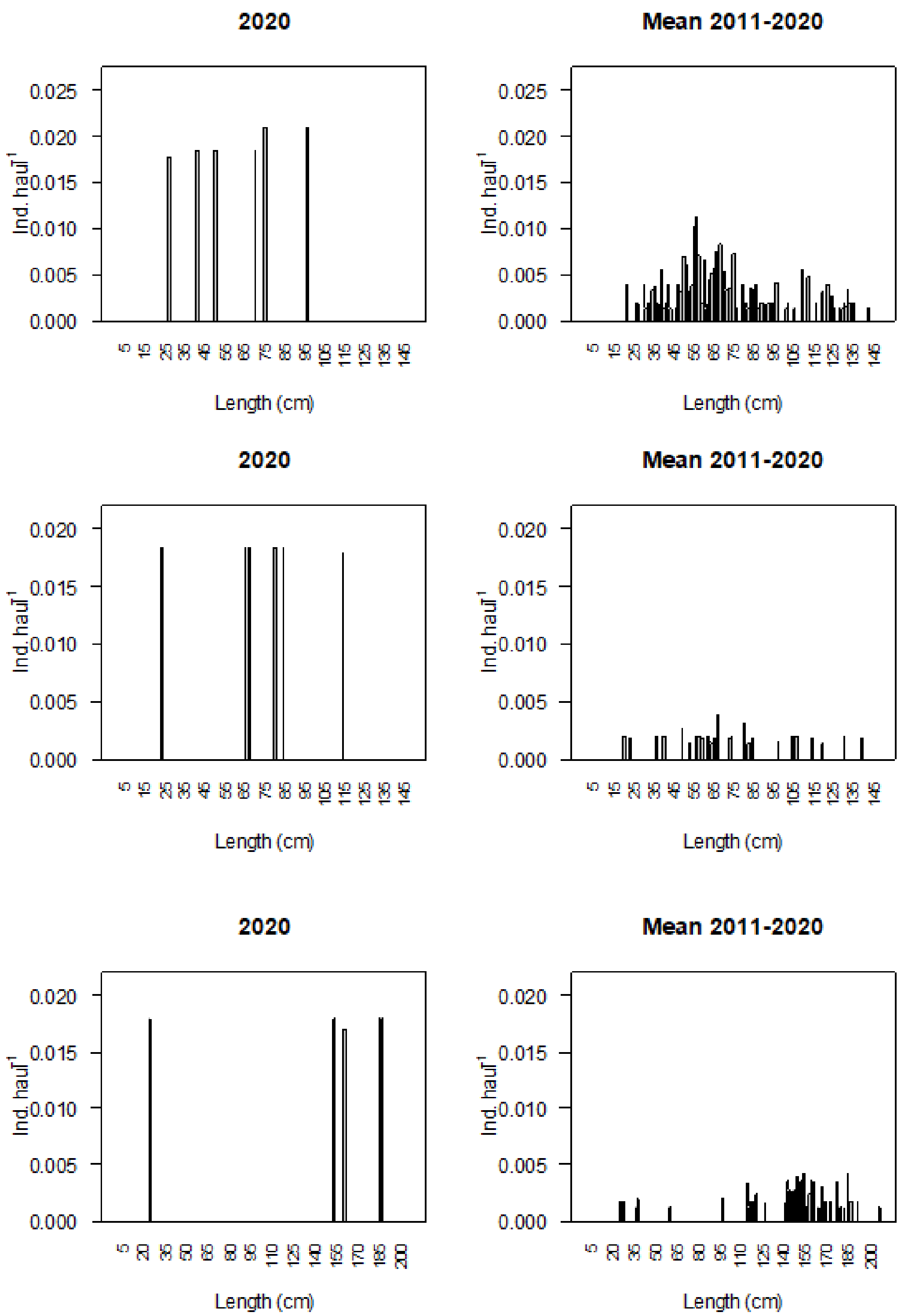

Figure 26.24. Stratified length distributions of *Dipturus batis* (top), *D. intermedius* (centre) and *D. nidarosiensis* (bottom) during Spanish surveys on the Porcupine Bank (2011–2020).

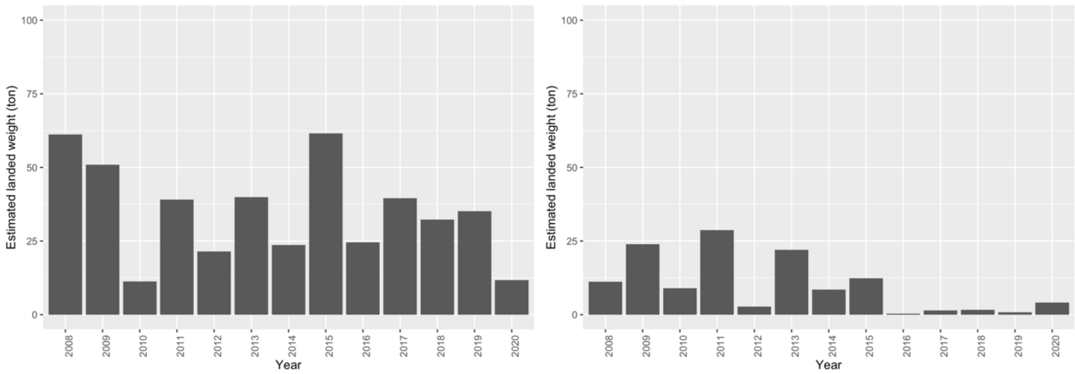

Figure 26.25. Estimated Portuguese landings of *Dipturus oxyrinchus* from Division 9.a by fleet segment: polyvalent (left) and trawl (right).

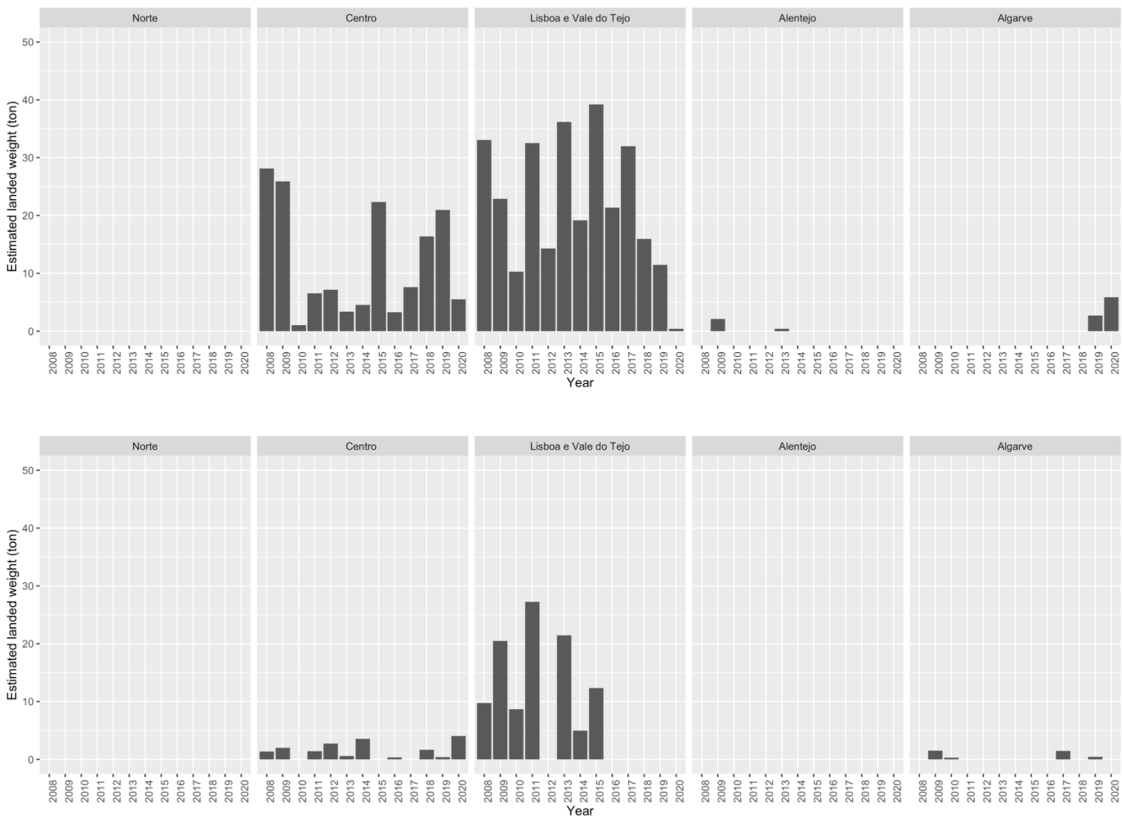

Figure 26.26. Estimated Portuguese landings of *Dipturus oxyrinchus* from Division 9.a by fleet segment (polyvalent: top; trawl: bottom) and region (from north to south).

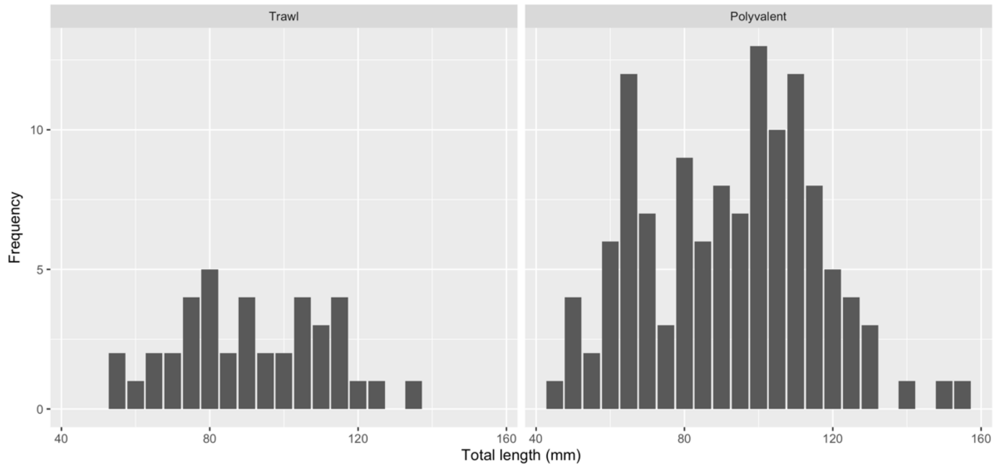

Figure 26.27. Length-frequency distribution of *Dipturus oxyrinchus* sampled in Portuguese landings from Division 9.a (2008–2020) by fleet segment (left: trawl, n = 112; right: polyvalent, n = 401). Data was not raised to the total estimated catch of the fleet.

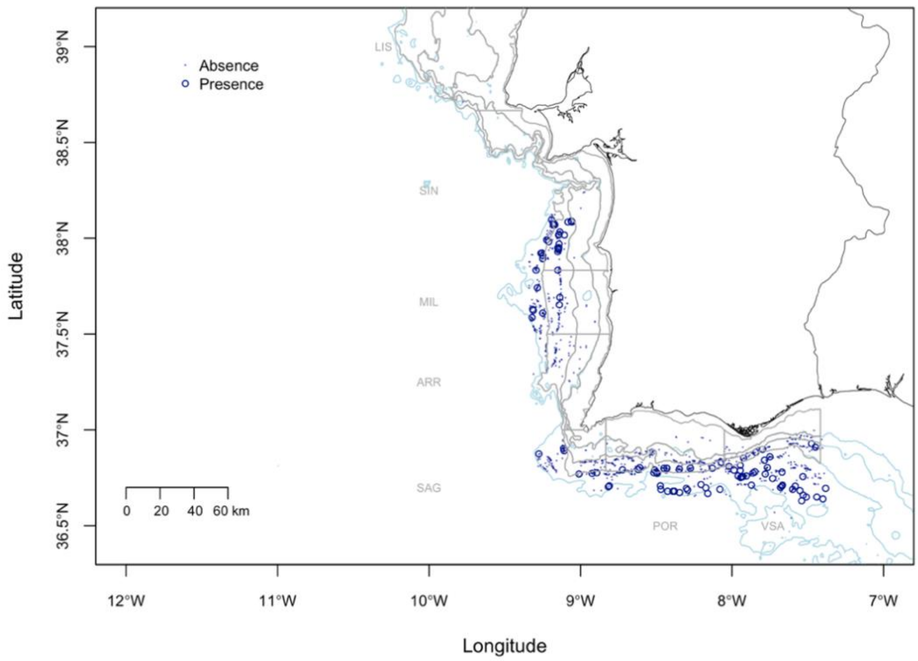

Figure 26.28. Presence/absence distribution of *Dipturus oxyrinchus* sampled in NepS (FU 28–29) from 1997 to 2018.

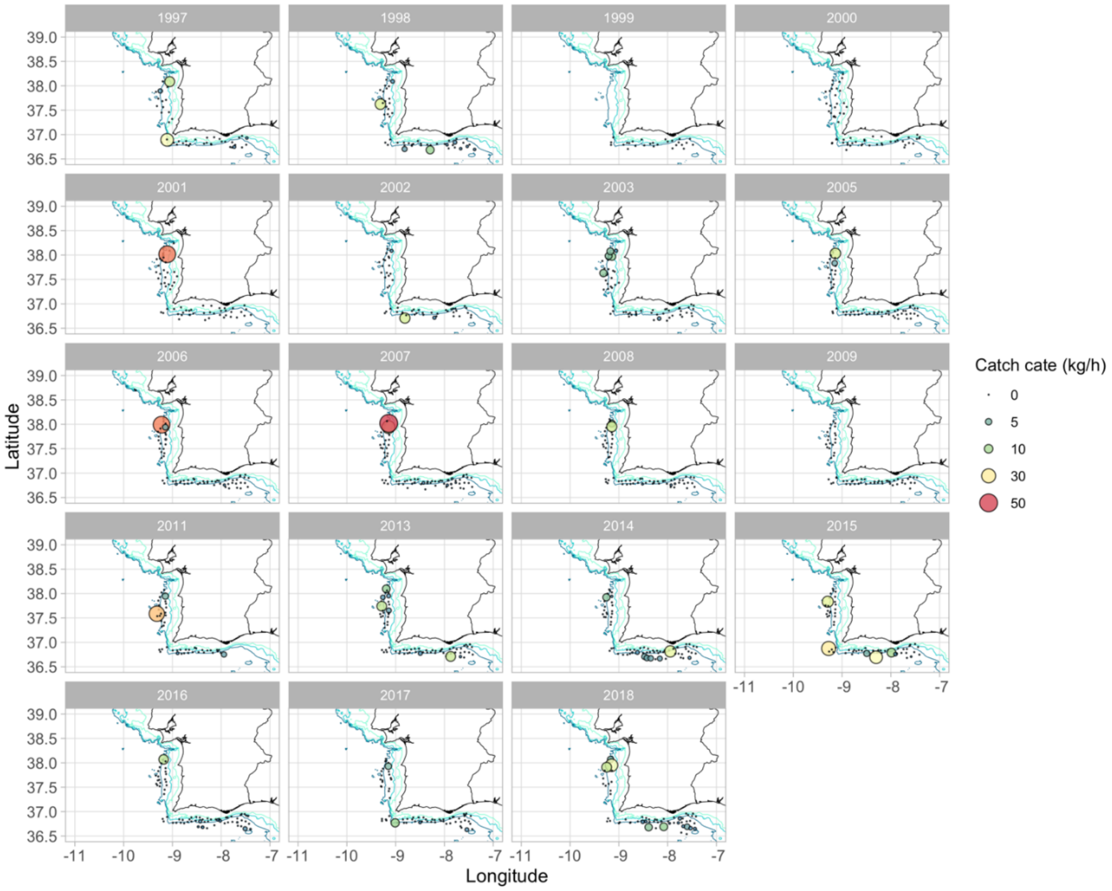

Figure 26.29. Catch distribution (n.h^{-1}) of *Dipturus oxyrinchus* sampled in NepS (FU 28–29) by year, from 1997 to 2018.

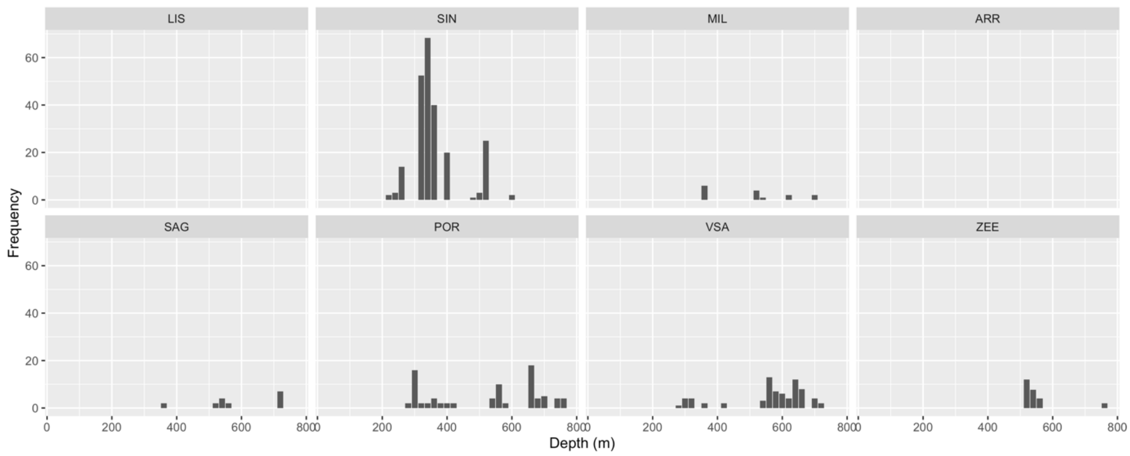

Figure 26.30. Bathymetric range of *Dipturus oxyrinchus* sampled in NepS (FU 28–29) from 1997 to 2018, by sector.

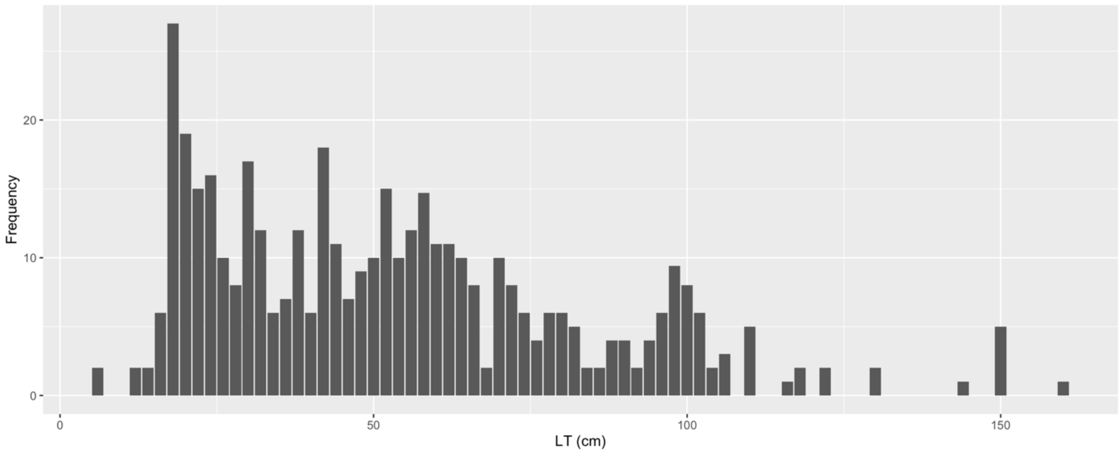

Figure 26.31. Length-frequency distribution of *Dipturus oxyrinchus* during NepS (FU 28–29) for the period 1997–2018.

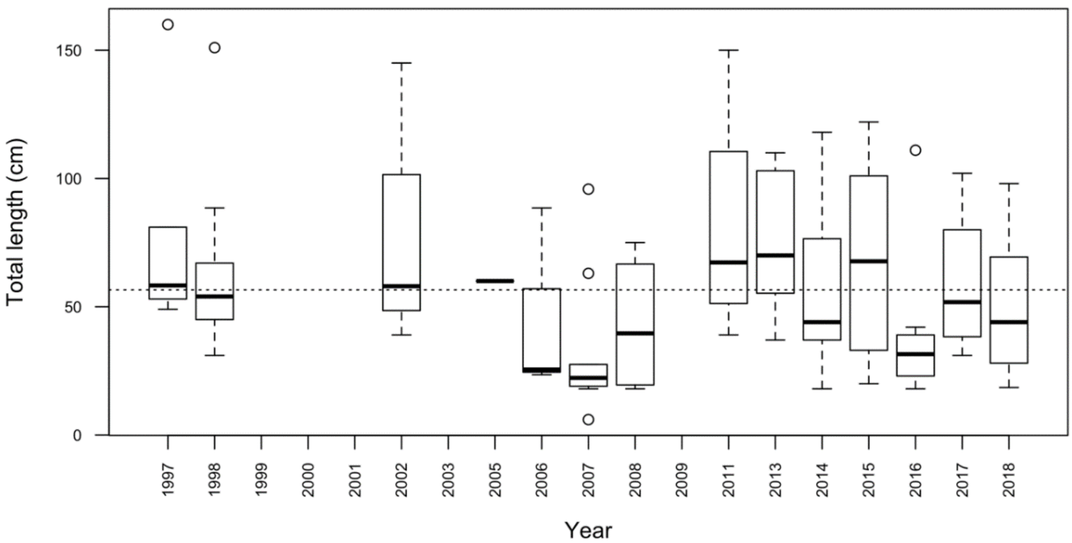

Figure 26.32. Total length variation of *Dipturus oxyrinchus*, by year on NepS (FU 28–29) (dashed line represents the mean annual length for 1997–2018).

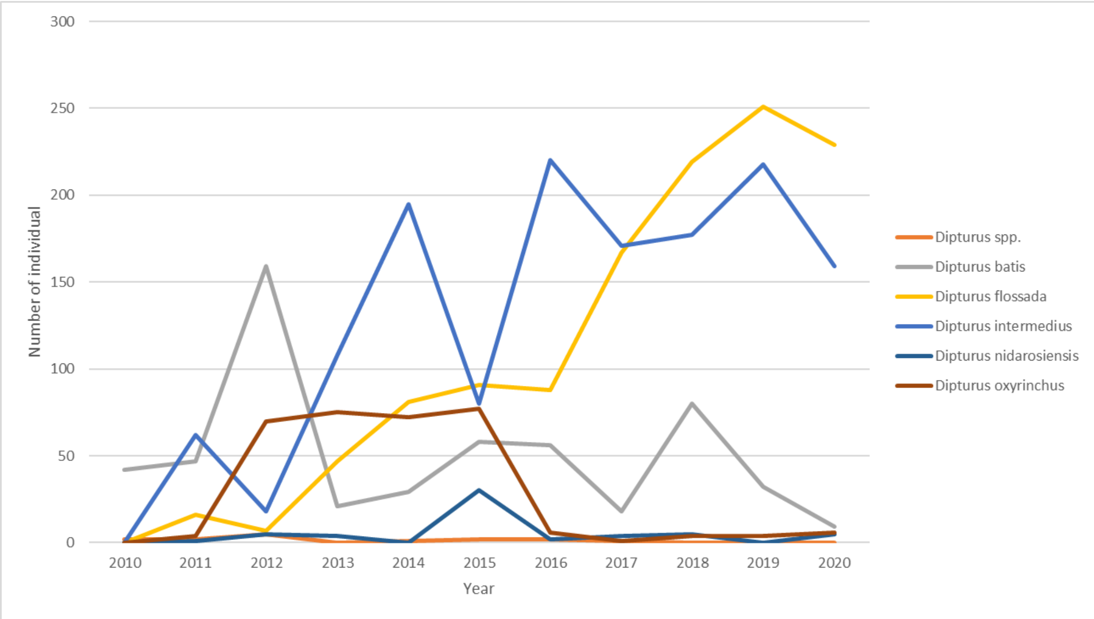

Figure 26.33. Number of individual *Dipturus* records per species (2010–2020) from those research surveys available on DATRAS.

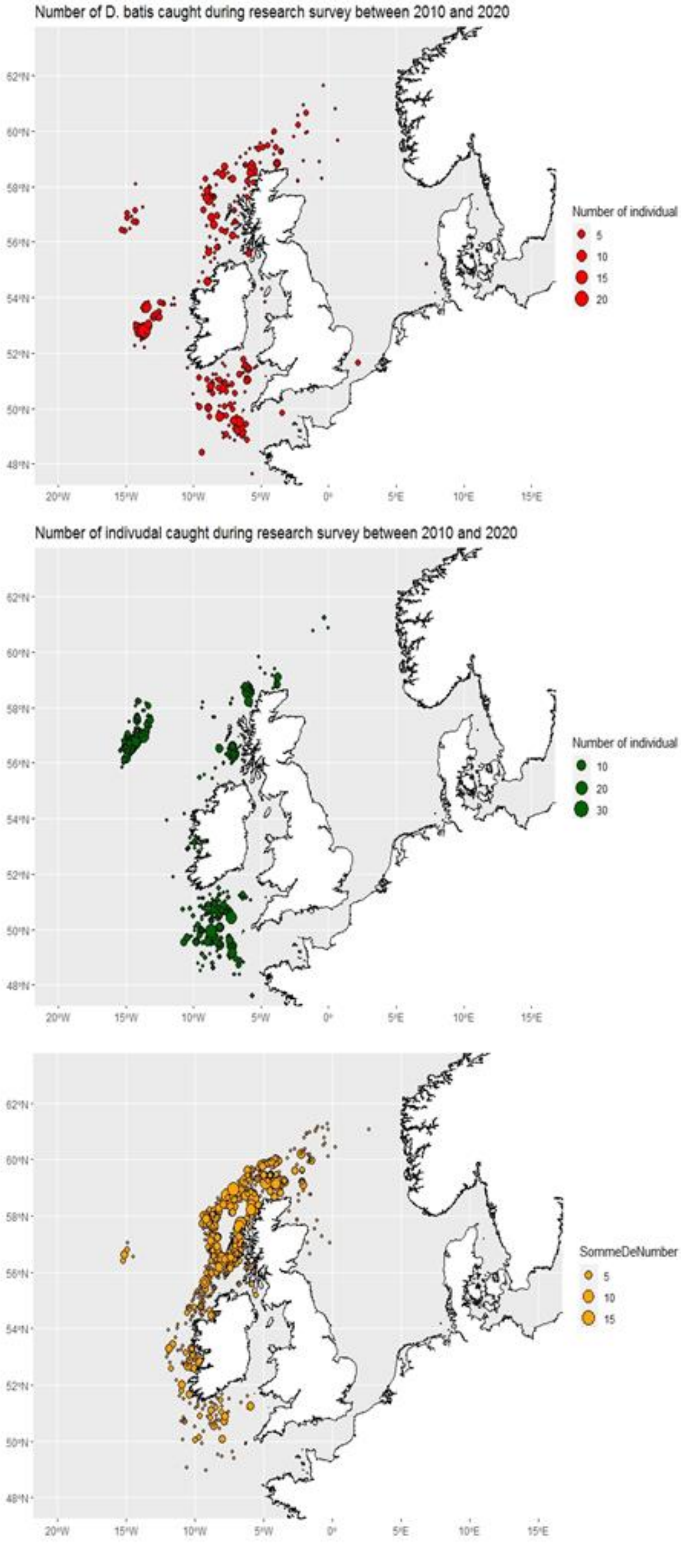

Figure 26.34. Spatial distribution and catch rates of *Dipturus batis*-complex (top, n = 551), *Dipturus batis/Dipturus flossada* (centre, n = 1196) and *Dipturus intermedius* (bottom), as recorded during research vessel surveys between 2010 and 2020 (n = 1408).

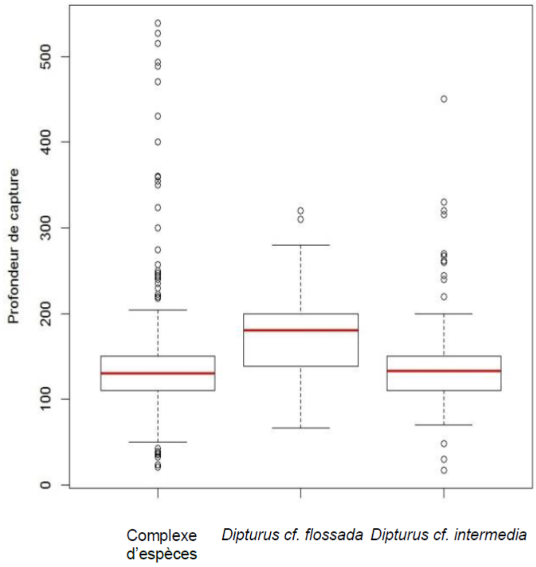

Figure 26.35. Boxplot on depth range (m) for common skate complex (n = 1242), *Dipturus batis* (n = 209; labelled as "*D. cf. flossada*") and *D. intermedius* (n = 443; labelled as ''*D. cf. intermedia''*) recorded during research vessel trawl surveys prior to 2015. Red line is the median depth of catch. Source: Barreau *et al.* (2016).

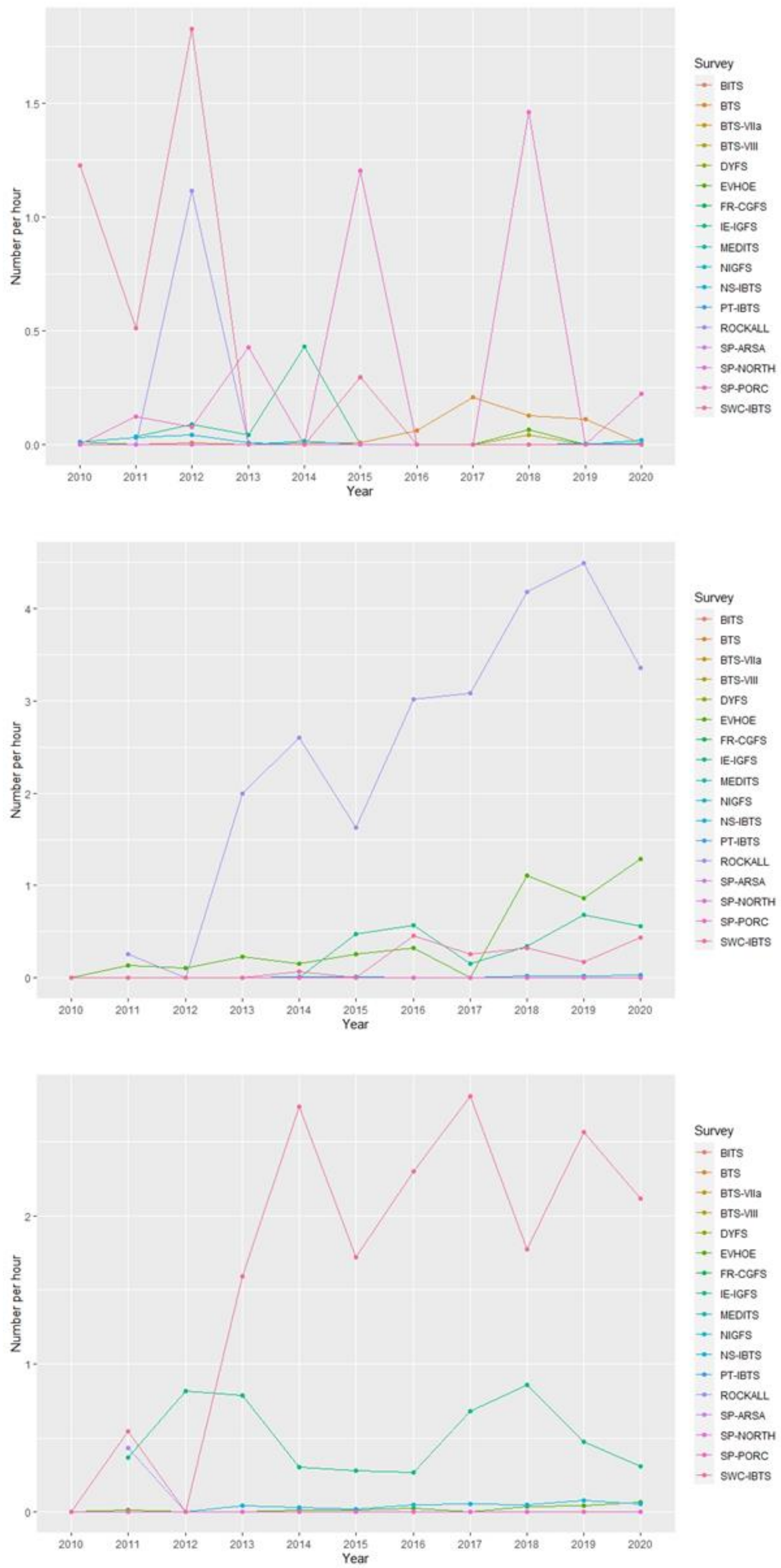

Figure 26.36. Nominal catch rates (number per hour) for common skate complex (top), common blue skate *Dipturus batis* (centre) and flapper skate *Dipturus intermedius* (bottom) as reported during trawl surveys available in DATRAS (2010–2020).

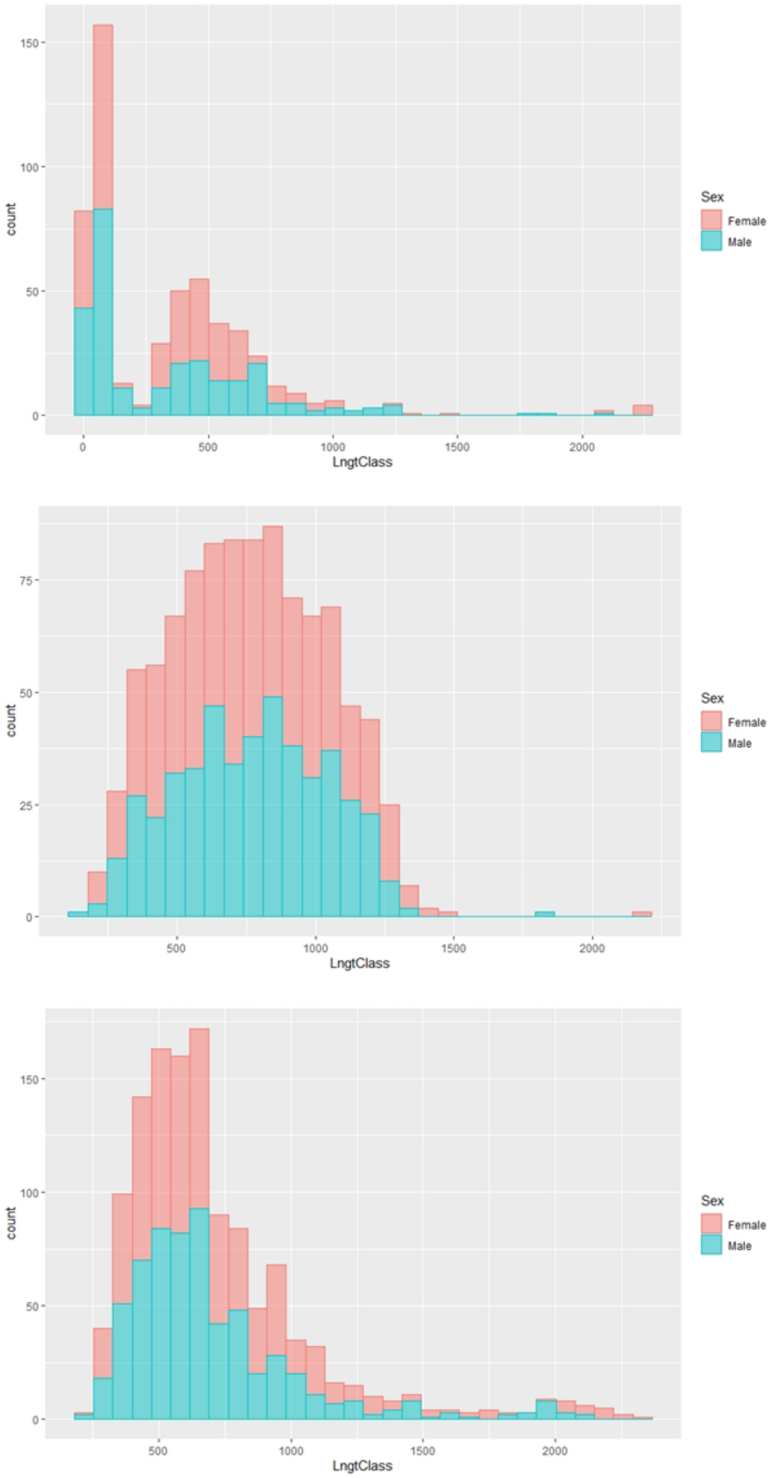

Figure 26.37. Length-frequency distributions of common skate complex (top, n = 537), common blue skate *Dipturus batis* (centre, n = 967) and flapper skate (bottom, n = 1249), as observed in scientific trawl surveys from DATRAS data.

27 Other issues

27.1 Code of conduct and conflict of interest

As knowledge provider ICES gives a high priority to credibility, legitimacy, transparency and accountability of their work. In this context, it is essential that experts contributing to ICES science and advice maintain scientific independence, integrity and impartiality. In addition, behaviours and actions of members should minimise any risk of actual, potential or perceived conflicts of interest. A conflict of interest arises when there is an actual, potential or perceived possibility that a member of the group makes a contribution to ICES work that is not based on a systematic scientific review of the available information and evidence or when decisions or outcomes may be influenced, or are perceived to be influenced, by self-interest or external pressures and other factors.

The Code of Conduct drawn up by ICES is to ensure transparency and responsibility in ICES work and to preserve the role of ICES as knowledge provider. The code of conduct applies to scientists participating in ICES Expert Groups, Review and Advice Drafting Groups as well as ACOM and SCICOM meetings.

ICES has requested the chairs of the working group to address the Code of Conduct and Conflict of Interest at the start of the meeting. All participants at the meeting, including the chairs, are required to declare any Conflicts of Interest and their commitment to agree with the Code of Conduct before their work commences. In 2020, all participants, including the chairs, declared no Conflict of Interest and agreed to abide with the Code of Conduct.

27.2 Joint ICES-ICCAT meeting

One of the ToRs for WGEF 2020 was to further develop proposed ToRs for a potential joint ICES-ICCAT meeting in 2020 to (i) assess porbeagle shark and (ii) collate available biological and fishery data on thresher sharks in the Atlantic.

In 2009, ICES and ICCAT held a joint meeting to coordinate their respective work on elasmobranchs. Issues considered at this meeting included fisheries, species-specific landings data and biological parameters being collected on the NEACS. Assessments for the NE Atlantic stocks of spurdog *Squalus acanthias* and porbeagle *Lamna nasus* were undertaken and the results were published in an ICES report (ICES, 2009).

Another joint meeting, focussing on porbeagle had been proposed for 2020. Due to COVID-19, it was impossible to organise an in-person meeting and it was decided to cancel the joint meeting. ICCAT continued the work on porbeagle and organised an online meeting (15–22 June) to discuss the northwest Atlantic and southern hemisphere porbeagle stocks. The aim of the meeting was to assemble and review all available porbeagle information and assess the status of the stocks. Members of WGEF responsible for the Northeast Atlantic porbeagle assessment have attended the online meeting. It is envisaged to organise a joint ICES-ICCAT meeting to collaborate and revisit (i.e. benchmark) the assessment of the Northeast Atlantic porbeagle stock in 2022. This joint ICES-ICCAT meeting would be very timely, given that ICES advice for this stock is scheduled for 2023.

27.3 Follow recommendations from WKSHARK5

One of the recurring issues in WGEF is the lack of discard data in the assessment. This prevents the shift from providing landings advice to catch advice. Despite two dedicated workshops on the use of discard data in stock assessments (WKSHARK3 and WKSHARK5), it is still difficult to move forward on this issue. In WGEF 2020, a discard table has been configured collating the submitted discard data available in the WGEF accessions folders. This overview demonstrates there is a high number of discrepancies between years and data are inconsistent or missing. It was decided that the discard data available to the group were not of sufficient quality to use in the assessments at this stage for most of the stocks. Moreover, the issues exposed by both WKSHARK3 and WKSHARK5 are too complex to be solved during the Expert Group meeting. A proper review of the available discard data as well as issues in terms of raising, data quality, discard retention patterns and survival is needed.

In WGEF 2020, ICES guidelines for first time catch advice were consulted for two stocks of cuckoo ray in the Bay of Biscay and Iberian waters (rjn.27.8c and rjn.27.9a). These are in line with the proposal made in WKSHARK5 on how to include discard information into the advisory process for elasmobranch fishes. Here, the North Sea thornback ray (*Raja clavata*) was used as an example stock to test the raising procedure and advice method. The regular advice for 2018 and 2019 for *R. clavata* in Subarea 4 and divisions 3.a and 7.d based on previous landings is compared with an advice for 2018 and 2019 when catch data would have been used (ICES, 2020).

In the WGEF 2019 report, it was already recommended that ICES initiate a dialogue with DG Mare to explore the possibility of funding or initiate a project to address the serious issues surrounding the collection and registration of discard data, as well as how to include survivability, in order for the data to be used in future stock assessments. This recommendation still applies to discussions in WGEF 2020.

27.4 Follow recommendations from WKSKATE

In the WGEF 2019 meeting, a number of discrepancies in the survey data-base and survey use in the assessments were highlighted and discussed. For the assessment methods, it was discussed to standardize and revisit the methods for calculating survey indices. As the indices are fundamental for the work within WGEF, the group decided a dedicated workshop on the use of surveys in the stock assessments should be organised (WKSKATE). The intention was to have the meeting prior to the 2020 WGEF meeting. However, due to a multitude of meetings for this group in early 2020, WKSKATE was postponed and was held in November 2020. Given the large task, the meeting will be staggered, with the first meeting in 2020 for the stocks to be assessed in WGEF 2021, and another workshop in 2022 for the remaining stocks.

During the 2020 WGEF meeting, serious issues with the planning and execution of Portuguese fisheries surveys were noted. These surveys are essential for advice on fishing opportunities on elasmobranchs in Iberian waters. A different approach using a commercial standardized LPUE time-series index of the Portuguese fleet was presented. While this method is already been applied to blonde ray in Division 9.a (Atlantic Iberian waters), the Expert Group decided an evaluation of the method was required before being applied to other stocks. As such, the use of a commercial standardized LPUE for some of the Iberian stocks was explored and reviewed within WKSKATE 2021 (ICES, 2021a).

27.5 WKSKATE Scheduling

In 2019, it was agreed that a dedicated workshop was needed to examine the use of surveys in the assessment of elasmobranchs. New surveys and time series and a lack of standardization amongst stocks meant that current assessment inputs and combination methods may no longer be the best sources of information on stock status. A Workshop on the use of surveys for stock assessment and Reference Points for Rays and Skates (WKSKATE) was proposed and accepted by ACOM.

WKSKATE was successfully held online in November 2020 (ICES, 2021a). Primarily due to constraints caused by COVID-19, it was decided prior to the meeting to concentrate on stocks that were due to be assessed by WGEF in 2021, namely skates and ray stocks in the North Sea. It was also decided to examine skate and ray stocks in Biscay and Iberia that were affected by the cessation of Portuguese surveys. It was therefore planned to hold a second WKSKATE workshop in late 2021/early 2022 that would examine stocks due for assessment by WGEF in 2022, particularly skate and ray stocks in the Celtic Seas Ecoregion. A third and final workshop (WKSKATE3) would examine the surveys used to assess the remaining stocks, primarily sharks, including catsharks, in 2023 or 2024.

It became clear during WGEF 2021 that there were very large time demands being made on ICES elasmobranch experts in 2021 and 2022. In addition to the proposed WKSKATE2 meeting, ICES has scheduled a SPICT workshop that members would be expected to attend, as SPICT is proposed for use in Category 3 assessments in 2022. Training will be required prior to this workshop for some experts. There is also a benchmark assessment for four elasmobranch stocks in Spring 2022 and the required Data Evaluation Workshop prior to this, expected in November 2021.

Because of the competing time pressures, and the fact that the outputs of the SPICT workshop may affect how Celtic Seas stocks are assessed in 2022, it was decided to defer the WKSKATE2 workshop until after WGEF 2022, likely November 2022.

27.6 Expected surveys issues due to COVID-19

COVID-19 induced some disruptions or changes in the planning of scientific surveys. As these surveys are crucial to the assessment work of WGEF, the group made an inventory of the surveys. Hereby the participants indicated whether surveys where carried out or not in 2020 and what is expected for 2021. Table 26.6.1 shows the outcome of the inventory. With the exception of Portuguese surveys which are uncertain, it is not expected there will be major gaps in the planning of the scientific surveys. Of course, it cannot be stated with any certainty that surveys will be carried out as this will depend on the situation with COVID-19 at that point in time.

Table 26.6.1. Expected continuation of relevant surveys for elasmobranch assessments under COVID-19.

Country	Survey	Availability of 2020 data	Availability of 2021 data (surveys in the first semester)	Expected continuation in 2021 (surveys in the second semester)
Belgium	NS-BTS-Q3	Yes		Yes
Netherlands	NS-BTS-Q3	Yes		Yes
	NS-IBTS-Q1	Yes	Yes	
France	FR-CGFS-Q4	Yes		Yes
	FR-EVHOE-Q4	Yes (see section 26.7)		Yes
	NS-IBTS-Q1	Yes	Yes	
Germany	NS-IBTS-Q1	Yes	Yes	
Denmark	NS-IBTS-Q1	Yes	Yes	
	NS-IBTS-Q3	Yes		Yes
UK	UK(E&W)-BTS-Q3	Yes		Yes
	NS-IBTS-Q3	Yes		Yes
Ireland	IGFS-WIBTS-Q4	Yes		Yes
Norway	NS-IBTS-Q1	Yes	Yes	
	NS-IBTS-Q3	Yes		Yes
Sweden	NS-IBTS-Q1	Yes	Yes	
Spain	SpGFS-WIBTS-Q4	Yes		Yes
	SpGFS-GC-WIBTS-Q1	Yes	Yes	
	SP-ARSA-Q1	yes	No	
	SP-ARSA-Q4	Yes		Yes
Portugal	PtGFS-WIBTS-Q4	Yes		uncertain
	ARQDAÇO	No		?

27.7 Other survey issues

In 2020, the FR-CGFS survey in the Eastern English Channel (Division 7.d) sampled only French waters because the request for authorisation to work in UK waters was not send to UK authorities in due time. For some stocks, the effect of the lack of sampling in UK waters on biomass indicators was estimated by comparing the indicator calculated with all sampled strata to the indicator calculated excluding strata not sampled in 2020. For stocks where the impact or the missing strata was large or could be not assessed, the year 2020 of CGFS was excluded from the biomass index. Table 26.7.1 describes the way the lack of CGFS data was handled for stocks where this survey is suitable.

Table 26.7.1. Handling of the lack of sampling from CGFS-Q4 in UK waters in 2020 for assessment and advice.

Stock	Survey used in the biomass indicator	Use of CGFS-Q4 data
rjc.27.3a47d	IBST-Q1, IBTS-Q3, BTS-ENG-Q3, BTS-BE-Q3, CGFS-Q4	2020 data excluded
rjc.27.4c7d	CGFS-Q4	2020 data excluded (index A for the index ratio based on 2019 only)
syc.27.3a47d	IBST-Q1, IBTS-Q3, BTS-Eng-Q3, CGFS Q4, BTS-BE-Q3	2020 data excluded
sdv.27.nea	IBTS–Q1, IBTS–Q3, EVHOE–WIBTS–Q4, CGFS–Q4, IGFS–WIBTS–Q4	2020 data used (impact of missing strata estimated minor)
syt.27.67	UK(E&W)-BTS-Q3, CGFS-Q4	2020 data excluded

In 2019, both PtGFS-WIBTS-Q4 and NepS (FU 28–29) were not conducted due to legal constraints of national scope that turned unfeasible the hiring of fishing and vessel crew on time to undertake the survey. In 2020, the NepS (FU 28–29) was still not conducted, due to the same issue; and the PtGFS-WIBTS-Q4 survey was carried out in the new RV "Mário Ruivo" (Dimensions = 75.6 m * 15 m, Ton = 2290 tonnes) and only 6% of the planned number of fishing hauls was achieved; this was due to a combination of legal/logistic constraints and COVID-19 pandemic that largely delayed the start of the survey until the end of the official time period (4th quarter) and year. The two surveys are planned to be conducted in 2021 in the RV "Mário Ruivo".

27.8 Future benchmarks

In contrast to many other assessment Expert Groups, WGEF has few stocks that has gone through a benchmark process. So far, two deep-water shark species (i.e. *Centrophorus squamosus* and *Centroscymnus coelolepis*) were part of the benchmark assessment of deep-water stocks in 2010 (WKDEEP; ICES, 2010a) and a benchmark assessment for spurdog (*Squalus acanthias*) was carried out through correspondence in 2021 (ICES, 2021b). In recent years, more effort has been made into exploring new assessment models and acquiring relevant data for assessments. As a result, in 2020, WGEF proposed potential benchmarks for several stocks which will be held in 2022 and 2023.

Porbeagle

A joint ICES-ICCAT meeting focussing on porbeagle was planned for 2020. This joint meeting would form the basis for the preparatory work to conduct a benchmark on the Northeast Atlantic porbeagle stock in 2021. At the joint meeting, available data as well as assessment methodologies (e.g. SPiCT) would be evaluated. Due to COVID-19, the joint meeting was cancelled and it has been agreed to postpone the benchmark to 2022 which is line with the update of the assessment in 2023.

The current timeline for the benchmark consists of preparatory work done during WGEF 2021. During the meeting, new data on tagging and genetic work was presented. Also, the preparatory work may include an update of SPiCT, but may also address new assessment methods developed within ICCAT to assess the North-western and Southern hemisphere stocks. In addition, a data preparation workshop will be held late November 2021, followed by a benchmark meeting in March 2022. The benchmark is likely to become a joint ICES-ICCAT workshop.

Rays assemblage in the North Sea and Bay of Biscay

In 2020 WGEF, several research studies exploring and evaluating methods to estimate population size of rays have been presented. The studies ranged from using genetic approaches (Close-kin Mark recapture) to using surplus production models and multispecies models (State-Space Bayesian Models). While most studies are ongoing, the presented results looked promising and capable of moving the assessments of several stocks to a next level (i.e. quantitative analyses and reference points). The methods presented are submitted as Working Documents and can be found on the 2020 WGEF SharePoint. As such, it was decided to initiate the process towards a benchmark for several ray stocks at once. It was decided to first have a benchmark for the Bay of Biscay (rjc.27.8), Celtic sea (rjn.27.678abd) and English Channel (rju.27.7de) stocks in 2022 as these stocks are up for advice in 2023. The three North Sea stocks (rjc.27.3a47d, rjm.27.3a47d and rjh.27.4c7d) will follow with a benchmark in 2023, being the year in which new advice is requested. As these stocks will go through a benchmark for the first time, ICES guidelines for the ICES benchmark process will need to be followed. This means, the quality of the available data as well as issues identified by the stock assessor should be evaluated. Working documents on the methods should be made available and presented to the Expert Group. A data compilation workshop will be held in late 2021, followed by the benchmark in March 2022 (WKELASMO).

27.9 References

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ICES. 2017. Report of the Workshop to compile and refine catch and landings of elasmobranchs (WKSHARK3), 20-24 February 2017, Nantes, France. ICES CM 2017/ACOM:38. 119 pp.

ICES. 2020. Workshop on incorporating discards into the assessments and advice of elasmobranch stocks (WKSHARK5, outputs from 2019 meeting). ICES Scientific Reports. 2:87. 94 pp. http://doi.org/10.17895/ices.pub.7494.

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Annex 2: Resolutions

2020/2/FRSG13 The **Working Group Elasmobranch Fishes** (WGEF), chaired by Jurgen Batsleer (Netherlands) and Pascal Lorance (France), will meet online from 15 – 24 June 2021 to:

a) Address generic ToRs for Regional and Species Working Groups.

b) Update the description of elasmobranch fisheries for deep-water, pelagic and demersal species in the ICES area and compile landings, effort and discard statistics by ICES Subarea and Division, and catch data by NEAFC Regulatory Area. Describe and prepare a first Advice draft of any emerging elasmobranch fishery with the available data on catch/landings, fishing effort and discard statistics at the finest spatial resolution possible in the NEAFC RA and ICES area(s);

c) Evaluate the stock status for the provision of biennial advice due in 2021 for: (i) skate stocks in the North Sea ecoregion, the Azores and MAR; (ii) catsharks (*Scyliorhinidae*) in the Greater North Sea, Celtic Seas and Bay of Biscay and Iberian Coast ecoregions; (iii) smooth-hounds in the Northeast Atlantic; and (iv) tope in the Northeast Atlantic)

d) Conduct exploratory analyses and collate relevant data in preparation for the evaluation of other stocks (Porbeagle in the NE Atlantic; and skates in the Celtic Seas and Bay of Biscay and Iberian Coast ecoregions) in preparation for more detailed biennial assessment in 2022;

e) Follow the outcomes of WKSKATE and to make the best use of survey indices in the assessments where appropriate.

f) Take note of the outcome of the proposed stand-alone expert meeting dealing with the issue of missing data in the Portuguese surveys and the solutions suggested.

g) Collate discard data from countries and fleets according to the ICES data call. Follow recommendations from WKSHARK3 and 5 to address the following issues: data quality and onboard coverage; raising factors; discard retention patterns between fleets and countries; and consider the output of WKSURVIVE to address discard survival and advise on how to include discard information in the assessment and advice accordinly;

h) Carry out exploration analysis of effort data for stocks where time-series of effort may be used to decide on the application of the PA buffer. The use of effort data analysed in other ICES working groups should be favored, liaise with WGMIXFISH and WGSFD.

i) Further develop MSY proxy reference points relevant for elasmobranchs and explore/apply in MSY Proxies analyses for selected stocks;

j) Further develop the ToR for a proposed joint ICCAT-ICES meeting on porbeagle and other pelagic sharks.

k) Work intersessionally to draft/update stock annexes and develop a procedure and schedule for subsequent reviews.

l) Evaluate available data at species-specific level within the common skate-complex (*Dipturus* spp.) stock units in order to further increase our understanding of each individual species and their current status.”

The assessments will be carried out on the basis of the stock annex in National Laboratories, prior to the meeting. The assessments must be available for audit on the first day of the meeting.

Material and data relevant for the meeting must be available to the group no later than 14 days prior to the starting date.

WGEF will report by 9 August 2021 for the attention of ACOM.

Generic ToRs for Regional and Species Working Groups

2020/2/FRSG01 The following ToRs apply to: AFWG, HAWG, NWWG, NIPAG, WGWIDE, WGBAST, WGBFAS, WGNSSK, WGCSE, WGDEEP, WGBIE, WGEEL, WGEF, WGHANSA and WGNAS.

The working group should focus on:

a) Consider and comment on Ecosystem and Fisheries overviews where available;

b) For the aim of providing input for the Fisheries Overviews, consider and comment on the following for the fisheries relevant to the working group:

   i) descriptions of ecosystem impacts on fisheries

   ii) descriptions of developments and recent changes to the fisheries

   iii) mixed fisheries considerations, and

   iv) emerging issues of relevance for management of the fisheries;

c) Conduct an assessment on the stock(s) to be addressed in 2021 using the method (assessment, forecast or trends indicators) as described in the stock annex and produce a **brief** report of the work carried out regarding the stock, providing summaries of the following where relevant:

   i) Input data and examination of data quality; in the event of missing or inconsistent survey or catch information refer to the ACOM document for dealing with COVID-19 pandemic disruption and the linked template that formulates how deviations from the stock annex are to be reported.

   ii) Where misreporting of catches is significant, provide qualitative and where possible quantitative information and describe the methods used to obtain the information;

   iii) For relevant stocks (i.e., all stocks with catches in the NEAFC Regulatory Area), estimate the percentage of the total catch that has been taken in the NEAFC Regulatory Area in 2020.

   iv) Estimate MSY reference points or proxies for the category 3 and 4 stocks

   v) Evaluate spawning stock biomass, total stock biomass, fishing mortality, catches (projected landings and discards) using the method described in the stock annex;

      1) for category 1 and 2 stocks, in addition to the other relevant model diagnostics, the recommendations and decision tree formulated by WKFORBIAS (see Annex 2 of https://www.ices.dk/sites/pub/Publication%20Reports/Expert%20Group%20Report/Fisheries%20Resources%20Steering%20Group/2020/WKFORBIAS_2019.pdf) should be considered as guidance to determine whether an assessment remains sufficiently robust for providing advice.

      2) b. If the assessment is deemed no longer suitable as basis for advice, consider whether it is possible and feasible to resolve the issue through an interbenchmark. If this is not possible, consider providing advice using an appropriate Category 2 to 5 approach.;

   vi) The state of the stocks against relevant reference points;

   Consistent with ACOM's 2020 decision, the basis for Fpa should be Fp.05.

      1) 1. Where Fp.05 for the current set of reference points is reported in the relevant benchmark report, replace the value and basis of Fpa with the information relevant for Fp.05

2) 2. Where Fp.05 for the current set of reference points is not reported in the relevant benchmark report, compute the Fp.05 that is consistent with the current set of reference points and use as Fpa. A review/audit of the computations will be organized.

3) 3. Where Fp.05 for the current set of reference points is not reported and cannot be computed, retain the existing basis for Fpa.

vii) Catch scenarios for the year(s) beyond the terminal year of the data for the stocks for which ICES has been requested to provide advice on fishing opportunities;

viii)Historical and analytical performance of the assessment and catch options with a succinct description of associated quality issues. For the analytical performance of category 1 and 2 age-structured assessments, report the mean Mohn's rho (assessment retrospective bias analysis) values for time series of recruitment, spawning stock biomass, and fishing mortality rate. The WG report should include a plot of this retrospective analysis. The values should be calculated in accordance with the "Guidance for completing ToR viii) of the Generic ToRs for Regional and Species Working Groups - Retrospective bias in assessment" and reported using the ICES application for this purpose.

d) Produce a first draft of the advice on the stocks under considerations according to ACOM guidelines.

i. In the section 'Basis for the assessment' under input data match the survey names with the relevant "SurveyCode" listed ICES survey naming convention *(restricted access)* and add the "SurveyCode" to the advice sheet.

e) Review progress on benchmark issues and processes of relevance to the Expert Group.
i) update the benchmark issues lists for the individual stocks;
ii) review progress on benchmark issues and identify potential benchmarks to be initiated in 2022 for conclusion in 2023;
iii) determine the prioritization score for benchmarks proposed for 2022–2023;
iv) as necessary, document generic issues to be addressed by the Benchmark Oversight Group (BOG)

f) Prepare the data calls for the next year's update assessment and for planned data evaluation workshops;

g) Identify research needs of relevance to the work of the Expert Group.

h) Review and update information regarding operational issues and research priorities on the Fisheries Resources Steering Group SharePoint site.

i) If not completed in 2020, complete the audit spread sheet 'Monitor and alert for changes in ecosystem/fisheries productivity' for the new assessments and data used for the stocks. Also note in the benchmark report how productivity, species interactions, habitat and distributional changes, including those related to climate-change, could be considered in the advice.

Information of the stocks to be considered by each Expert Group is available here.

Annex 3: Audits

Raj.27.1012

Review of ICES Scientific Report, *WGEF/Working Group on Elasmobranch Fishes*) *(2021*) (15-24 June)
Reviewer: Bárbara Serra Pereira
Expert group Chair: Jurgen Batsleer & Pascal Lorance
Secretariat representative: Iñigo Martinez

General

- Category 3 stock: advice for rays and skates in subareas 10 and 12 mainly based on survey index for *Raja clavata*, which represents around 90% of the skates caught in the Azorean demersal bottom longline survey; the species composition in commercial skate landings is unknown.
- No survey conducted in 2020 due to COVID-19 restrictions; index A based only on 2019.
- Length-base indicators (LBIs) reported from WKLIFEV were explored; the MSY proxy results show that exploitation for this stock is below the MSY level.
- There are no fisheries targeting skates on the MAR (ICES subareas 10, 12 and 14) with sporadic landings in recent years.
- Discarding is known to take place, but not quantified.
- No Stock Annex is available for this stock.

For single-stock summary sheet advice

raj.27.1012

Short description of the assessment as follows (examples in grey text):

1. Assessment type: category 3.
2. Assessment: accepted.
3. Forecast: NA, precautionary approached applied.
4. Assessment model: Azorean demersal bottom longline survey-based trends for thornback ray.
5. Consistency: following the advice rule for category 3, but considering only 1 recent year (2019). No survey conducted in 2020 due to COVID-19 restrictions.
6. Stock status: Unknown (information to define reference points are not available).
7. Management plan: There is no management plan available.

General comments

- The draft report section for this stock was available at time of the audit and contain all the information referred in the advice sheet.
- The PA buffer was last applied in 2019, therefore not applied this year.
- Although with some gaps in the data series and with lower levels that those observed between 2002 and 2007, the stock status has been relatively stable in the last 12 years.
- Catches kept at low levels, 2/3 of the advice.
- Stock with no TAC

Technical comments

- No survey conducted in 2020 due to COVID-19 restrictions; index A based only on one year (2019).
- The rounding was corrected according to ICES rules (applying to Tables 1,7 and 8)
- Suggestion: mention to the no TAC for this stock could be added to the report.

Conclusions

The assessment was carried out according to ICES guidelines for category-3 stocks. Minor corrections made to the advice in the audit, including update of values according to ICES rounding rules.

Some comments in the advice sheet still to be addressed by the secretariat:

- Figure 1 abundance index should be updated to include 2 orange lines (2019 and 2016-2018).

Rjh.27.4c7d

Review of ICES Scientific Report, (*WGEF/Working Group on Elasmobranch Fishes*) *(2021*) (15-24 June)
Reviewer: Loïc Baulier
Expert group Chair: Jurgen Batsleer & Pascal Lorance
Secretariat representative: Iñigo Martinez

General

Last time advice for rjh.27.4c7d was requested was in 2019. The advice for this year applies to 2022-2023. It is currently assessed as a Category-3 stock.
The stock size index used for assessment is based on the CGFS–Q4 survey (G3425). As this survey was only partially carried out in 2020, the trend of the index was calculated as the ratio of the 2019 index over the average of the previous 5 years instead of the last 2 years' average over the previous 5 years' average).
This stock is managed under a combined TAC, which was not agreed upon at the time of plenary. No stock annex is available for this stock.

For single-stock summary sheet advice

rjh.27.4c7d (Blonde ray (*Raja brachyura*) in divisions 4.c and 7.d (southern North Sea and eastern English Channel)

Short description of the assessment as follows (examples in grey text):

1. Assessment type: Category 3 assessment
2. Assessment: Accepted
3. Forecast: NA, precautionary approached applied
4. Assessment model: Category-3 stock, based on landings. Discards are unknown.
5. Consistency: following the advice rule for category 3 with not deviation from the advice rule.
6. Stock status: Unknown (information to define reference points are not available). No Stock Status table used this year in the advice.
7. Management plan: There is no management plan available.

General comments
The precautionary buffer was last applied in 2019 and its application was therefore not considered this year.
No errors detected in the advice sheet, the rounding was applied according to ICES rules.

Technical comments
The spatial coverage of the CGFS-Q4 (G3425) was partial in 2020 (no sampling in British waters). Hence, the stock size index for this year was deemed not representative and was not used in the assessment.
As only one survey is used to derive the stock size indicator, the index time series was not standardized. For the sake of clarity, the index is expressed in thousands tonnes in Figure 1.

Conclusions
The assessment was carried out according to ICES guidelines for category-3 stocks.

Sdv.27.nea

Review of ICES Scientific Report, (*WGEF/Working Group on Elasmobranch Fishes*) (*2021*) (15-24 June)
Reviewers: Katinka Bleeker
Expert group Chair: Jurgen Batsleer & Pascal Lorance
Secretariat representative: Iñigo Martinez

General
- Category 3 stock with last time advice was requested, was in 2019. The advice for this year applies to 2022-2023.
- Species-specific landings are unreliable, and are combined at genus level. Landings prior to 2005 are uncertain, but landings appear to have been reported more consistently in recent years.
- There is no TAC for this species
- Discarding is known to take place, but ICES cannot quantify the corresponding dead catch.
- No stock annex is available for this stock
- The stock size indicator is now based on five surveys, instead of three, following recommendation of WKSKATE (increasing the area covered within the stock unit).

For single-stock summary sheet advice

sdv.27.nea – Smooth-hound (*Mustelus* spp.) in subareas 1-10, 12, and 14 (the Northeast Atlantic and adjacent waters)

Short description of the assessment as follows:

1. Assessment type: category 3 update
2. Assessment: accepted
3. Forecast: NA, precautionary approached applied
4. Assessment model: Survey-based trends based on 5 surveys: NS-IBTS-Q1 (G1022), NS-IBTS-Q3 (G2829), EVHOE-WIBTS-Q4 (G9527), CGFS-Q4 (G3425) and IGFS-WIBTS-Q4 (G7212).

5. Consistency: following the advice rule for category 3 with no deviation from the advice rule.
6. Stock status: Unknown (information to define reference points are not available).
7. Management plan: ICES is not aware of any agreed precautionary management plan for smooth-hound in this area.

General comments

- The draft report section for this stock was available at the time of the audit and contained all the information referred in the advice sheet.
- The precautionary buffer was last applied in 2015, and has, therefore been considered again.

Technical comments

- The spatial coverage of the CGFS-Q4 was partial in 2020, as only the French waters of the English Channel were sampled. There is little evidence of an impact on the overall stock size indicator for starry smooth-hound. Therefore, the survey index for 2020 for this survey has been used in the assessment.

Conclusions

The assessment was carried out according to ICES guidelines for category 3 stocks.

Syc.27.3a47d

Review of ICES Scientific Report, (*WGEF/Working Group on Elasmobranch Fishes*) *(2021*) (15-24 June)
Reviewer: Loïc Baulier
Expert group Chair: Jurgen Batsleer & Pascal Lorance
Secretariat representative: Iñigo Martinez

General

Last time advice for syc.27.3a47d was requested was in 2019. The advice for this year applies to 2022-2023. It is currently assessed as a Category-3 stock.
The stock size index used for assessment is based on five surveys: .NS-IBTS-Q1 (G1022), NS-IBTS-Q3 (G2829) (these two indices are average prior to combination with the other indices), BTS-Eng-Q3 (G2453), CGFS Q4 (G3425) and BTS-BE-Q3 (G2453). The later survey was included for the derivation of the global index this year.
There is no TAC for this stock.
No stock annex is available for this stock.

For single-stock summary sheet advice

Lesser spotted dogfish (*Scyliorhinus canicula*) in Subarea 4 and in divisions 3.a and 7.d (North Sea, Skagerrak and Kattegat, eastern English Channel)

Short description of the assessment as follows (examples in grey text):

1. Assessment type: Category 3 assessment
2. Assessment : Accepted
3. Forecast: NA, precautionary approached applied
4. Assessment model: Category-3 stock, based on landings. Discards are unknown but suspected to represent a large part of the catch.

5. Consistency: following the advice rule for category 3 with not deviation from the advice rule. One survey added to derive the stock size indicator, compared to previous assessment.
6. Stock status: Unknown (information to define reference points are not available). No Stock Status table used this year in the advice.
7. Management plan: There is no management plan available.

General comments

The precautionary buffer was last applied in 2019 and its application was therefore not considered this year.
The rounding was applied according to ICES rules.
The reference of the WKSKATE report must be added to the list:
ICES. 2021a. Workshop on the use of surveys for stock assessment and reference points for rays and skates (WKSKATE; outputs from 2020 meeting). ICES Scientific Reports. 3:23. 177 pp. https://doi.org/10.17895/ices.pub.7948
and the mentions to ICES 2021 (a,b, or c) in the text should be corrected accordingly

Technical comments

The spatial coverage of the CGFS-Q4 (G3425) was partial in 2020 (no sampling in British waters). Hence, the stock size index from CGFS-Q4 for this year was deemed not representative and was not used in the assessment.
The indices from the different surveys were normalized before being combined (arithmetic mean) to produce the stock size estimator. The two indices from NS-IBTS (Q1 and Q3) were first combined so that the combined NS-IBTS index has the same weight as any of the other survey indices.
In Quality of the assessment, the first sentence, as currently formulated, suggests that this stock was treated as a case study during WKSKATE. This is not the case. However, the addition of the survey BE-BTS-Q3 to the calculation of the stock size index was considered by the WGEF on the basis of criteria defined during WKSKATE. Details are provided in the Group's annual report. Suggestion: "Fishery-independent trawl surveys indices were updated and combined following ~~recommendation of~~ **the criteria defined during** WKSKATE (ICES 2021a, c)
In Table 4, the mention "no TAC" should not appear for years 2022 and 2023

Conclusions

The assessment was carried out according to ICES guidelines for category-3 stocks, no errors appear in figures or rounding. Minor errors in the text are still to be corrected.

Syt.27.67

Review of ICES Scientific Report, *WGEF/Working Group on Elasmobranch Fishes*) *(2021)* (15-24 June)
Reviewer: Bárbara Serra Pereira
Expert group Chair: Jurgen Batsleer & Pascal Lorance
Secretariat representative: Iñigo Martinez

General

- Category 3 stock: advice for greater-spotted dogfish (*Scyliorhinus stellaris*) in subareas 6 and 7 (West of Scotland, southern Celtic Sea, and the English Channel).

- Landings and catch data are too unreliable to be used to advice on fishing opportunities. But an indication of the relative change in catch implied is provided.
- In recent years, landings data are improving, however, ICES is aware that data in the four last years are still incomplete. Discards and utilisation as pot bait are known to occur and are not quantified.
- The stock size indicator is based on 2 surveys: UK(E&W)–BTS–Q3 and CGFS-Q4. The latter was introduced in WGEF 2021 following the guidelines from WKSKATE (the stock was not addressed on the workshop).
- In 2020 the area coverage of the UK(E&W)–BTS–Q3 survey was reduced due to COVID-19 restrictions (7.a not covered) and UK waters of the English Channel were not sampled during the CGFS-Q4 survey. Therefore, the 2020 indices were considered not representative for this stock, and index A was based only in 2019.
- Stock Annex is available for this stock but needs update to include the use of the new survey (CGFS-Q4).

For single-stock summary sheet advice

syt.27.67

Short description of the assessment as follows (examples in grey text):

1. Assessment type: category 3.
2. Assessment: accepted.
3. Forecast: NA, precautionary approached applied.
4. Assessment model: survey-based trends, using a standardized biomass index of exploitable biomass: average of standardized indices from UK(E&W)–BTS–Q3 in divisions 7.a and 7.f in $Kg.hr^{-1}$ and CGFS-Q4 in Division 7.d in $Kg.km^{-2}$.
5. Consistency: following the advice rule for category 3 with no deviation from the advice rule.
6. Stock status: Unknown (information to define reference points are not available).
7. Management plan: There is no management plan available.

General comments

- The draft report section for this stock was available at time of the audit and contain all the information referred in the advice sheet.
- The basis for the advice was updated in 2021: i) inclusion of the CGFS-Q4, and ii) use of exploitable biomass instead of total biomass indexes; both updates followed the WKSKATE guidelines.
- A sentence stating the update of the basis of the assessment was lacking from the section 'Quality of the assessment'. A suggested sentence was added, formulated based on other stocks.
- Overall increasing trend in the biomass indicator since the beginning of the series, oscillating around a standardized mean value of 1.3 in the last 6 years.
- The PA buffer was last applied in 2017, and has, therefore, been considered and applied in 2021 (stock status relative to candidate reference points is unknown.)
- Stock with no TAC; catsharks are not subject to species-specific fisheries management measures in EU waters.

Technical comments

- In 2020 the area coverage of the UK(E&W)–BTS–Q3 survey was reduced due to COVID-19 restrictions (7.a not covered) and UK waters of the English Channel were not sampled during the CGFS-Q4 survey; index A based only on one year (2019).
- Although landings and catches are considered unreliable, a figure with the landings since 2005 is presented as auxiliary information in the section 'Quality of the assessment'.
- Sentence from "Issues relevant for the advice" incomplete. Added text according to other catsharks sheets (i.e., "retained as low-value bycatch"; confirm if true for this stock).
- Table 4 – advice for 2022 refer to a decrease in 4% but should be read 18%.
- Added two references used in the section 'Quality of the assessment' (i.e., WKSKATE and 2019 Advice Sheet). ICES, 2021 references reordered.
- Added footnote to explain NA value in 2020.
- The rounding was corrected according to ICES rules (applying to Tables 1 and 6)

Conclusions

The assessment was carried out according to ICES guidelines for category-3 stocks. Minor corrections made to the advice in the audit, including update of values according to ICES rounding rules and sentence added to 'Quality of the assessment' describing the updated of the basis for the assessment.

Stock Annex needs to be updated to include the use of CGFS-Q4.

Gag.27.nea

Review of ICES Scientific Report: Working Group on Elasmobranch Fishes (WGEF), on line meeting, 15-24 June 2021.
Reviewers: Gérard Biais
Expert group Chair: Jurgen Batsleer and Pascal Lorance
Secretariat representative: Inigo Martinez and Jette Fredslund

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General

- Cat 5 stock.
- No TAC, only some gear prohibitions (longlines, rod and lines).
- Large French contribution to total landing (75–80% in 2019 and 2020).
- Limited information on discards.
- No reliable abundance index series.
- A stock annex is currently missing.

For single-stock summary sheet advice

Stock: Tope (*Galeorhinus galeus*) in subareas 1–10, 12 and 14 (gag.27.nea)

Short description of the assessment as follows:

1. Assessment type: update, category 5 stock.
2. Assessment: No assessment.
3. Forecast: NA. Precautionary buffer applied in 2019; therefore, not applied in 2021.
4. Assessment model: not applicable.
5. Consistency: cat 5 with no deviation from the advice rule.
6. Stock status: Unknown (and no information on biomass trend).

7. Management plan: None for this stock.

General comments: none.

Technical comments
The causes of decreasing trend in Spanish landings from 2010 to 2015 should be commented as well as the large fluctuations of French landings before 1987.
The possibility to obtain an abundance index using commercial CPUE should be investigated.

Conclusions
The advice follows the rule for category 5. Same landings advised as in previous advice issued in 2019.

Raj.27.3a47d

Review of ICES Scientific Report, (*WGEF/ Working Group on Elasmobranch Fishes*) (*2021*) (*15-24 June*)
Reviewer: Laura Lemey
Expert group Chair: Jurgen Batsleer and Pascal Lorance
Secretariat representative: Inigo Martinez and Jette Fredslund

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General

For single-stock summary sheet advice

Raj.27.3a47d (Rays and skates (Rajidae) in Subarea 4 and in divisions 3.a and 7.d
(North Sea, Skagerrak, Kattegat and eastern English Channel)

Short description of the assessment as follows:

1. Assessment type: Update assessment
2. Assessment: No assessment
3. Forecast: No forecast
4. Assessment model: No assessment
5. Consistency: Consistent, similar to last year ICES cannot provide catch advice for these stocks due to a lack of reliable survey and catch data. Revised recent landings (ICES, 2016) are not considered reliable to provide advice because of progressive changes in the level of species-specific reporting.
6. Stock status: Unknown
7. Management plan: ICES is not aware of any agreed precautionary management plan for skates and rays in this area.

General comments
Landings data for 2017 and 2018 have been updated, as revised Danish data was supplied.

Technical comments
Suggestions were made in the advice sheet using track changes.

Conclusions
ICES cannot perform stock assessments nor provide catch advice for these stocks due to a lack of reliable survey and catch data.

Rjc.27.3a47d

Review of ICES Scientific Report, (*WGEF/ Working Group on Elasmobranch Fishes*) (*2021*) (*15-24 June*)
Reviewer: Laura Lemey
Expert group Chair: Jurgen Batsleer and Pascal Lorance
Secretariat representative: Inigo Martinez and Jette Fredslund

General

For single-stock summary sheet advice

Rjc.27.3a47d (Thornback ray *(Raja clavata*) in Subarea 4 and in divisions 3.a and 7.d (North Sea, Skagerrak, Kattegat, and eastern English Channel)

Short description of the assessment as follows:

1. Assessment type: Update assessment
2. Assessment: Category 3 assessment
3. Forecast: No forecast
4. Assessment model: Category 3 assessment applying two over five rule to the stock size indicator. Stock size indicator calculated using 5 surveys. The stock size biomass indicator ratio showed an increasing trend.
5. Consistency: Following the advice rule for category 3 stock with no deviation from the advice rule. One survey added to derive the stock size indicator, compared to previous assessments. CGFS-Q4 2020 data point was not included in the stock size index.
6. The species- specific landings data are incomplete prior to 2009, so have not been incorporated in this advice.
7. Stock status: Unknown (information to define reference points are not available).
8. Management plan: ICES is not aware of any agreed precautionary management plan for thornback ray in this area.

General comments
The precautionary buffer was last applied in 2019 and its application was therefore not considered this year.

Technical comments
Fisheries- independent trawl survey indices were updated and combined, following recommendations of WKSKATE[1]. The stock size indicator is based on five surveys, now including the BE-BTS-Q3, instead of four, which cover most of the stock area.

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[1] ICES. 2021a. Workshop on the use of surveys for stock assessment and reference points for rays and skates (WKSKATE; outputs from 2020 meeting). ICES Scientific Reports. 3:23. 177 pp. https://doi.org/10.17895/ices.pub.7948

The two indices from NS-IBTS (Q1-Q3) were combined so that the combined NS-IBTS index has the same weight as any of the other survey indices.

In 2020, the spatial coverage of the CGFS-Q4 focused only on the French waters of the English Channel, which impacted the CGFS- Q4 index for 2020. Therefore, the 2020 CGFS-Q4 indices were considered not to be representative for this stock.

Suggestions were made in the advice sheet using track changes.

Conclusions
The assessment has been performed correctly, following ICES guidance for assessing data limited stocks. Minor comments were made in the advice sheet. Please check unrounded calculation in Table 1 and follow rounding rules.

Rjh.27.4a6

Review of ICES Scientific Report, (*expert group/workshop title*) (*year*) (*dates*)
Reviewers: Inigo Martinez
Expert group Chair: Pascal Lorance and Jurgen Batsleer
Secretariat representative: Inigo Martinez

General

- Cat 5 stock.
- Blonde ray is managed under a combined TAC. TAC not agreed at time of plenary
- LBIs for blonde ray could be try but may be problematic. It is data limited, with potential ID issues with spotted rays, bycatch may take more small blonde ray, seasonal/localised target fisheries likely to take larger blonde rays, so depending on data collection, underlying data for LBIs would not be informative...
- No Stock Annex is available for this stock.

For single-stock summary sheet advice

Rjh.27.4a6

Short description of the assessment as follows (examples in grey text):

1. Assessment type: cat 5
2. Assessment: no assessment
3. Forecast: NA but PAB applied on the catch options table
4. Assessment model: cat 5. i.e. assessment based on catches only. No discards used.
5. Consistency: following the advice rule for cat 5 with not deviation from the advice rule.
6. Stock status: Unknown (information to define reference points are not available). No SSTable used this year in the advice.
7. Management plan: There is no management plan available

General comments:
The precautionary buffer was last applied in 2018. Because there is no information on stock size or fishing pressure, the precautionary buffer was applied again in 2021.

Catches are ca. 3 times the advice (which is still low).

TAC form UK not agreed: what standard sentence. Need to fill at later date

Technical comments

Supporting graph to Issues: Stock size indicator of total biomass from two trawl surveys (NS–IBTS–Q1 and IGFS-WIBTS-Q4) relative to the time-series mean (2005-2020) but not considered indicative of trends.

Conclusions

Rounding need to be applied to the new calculated catch 7.2 => 7 tonnes

Rjm.27.3a47d

Review of ICES Scientific Report, (*WGEF/ Working Group on Elasmobranch Fishes*) (*2021*) (*15-24 June*)
Reviewer: Graham Johnston
Expert group Chair: Jurgen Batsleer and Pascal Lorance
Secretariat representative: Inigo Martinez and Jette Fredslund

For single-stock summary sheet advice

Rjm.27.3a47d Spotted ray (*Raja montagui*) in Subarea 4 and in divisions 3.a and 7.d (North Sea, Skagerrak, Kattegat, and eastern English Channel)

Short description of the assessment as follows:

1. Assessment type: Update assessment
2. Assessment: Category 3 assessment
3. Forecast: No forecast
4. Assessment model: Category 3 assessment applying two over five rule to the stock size indicator. Stock size indicator calculated using 2 surveys. The stock size biomass indicator ratio showed a decreasing trend.
5. Consistency: Following the advice rule for category 3 stock with no deviation from the advice rule.
6. The species- specific landings data are incomplete prior to 2009, so have not been incorporated in this advice.
7. Stock status: Unknown (information to define reference points are not available).
8. Management plan: ICES is not aware of any agreed precautionary management plan for spotted ray in this area.

General comments

The precautionary buffer was applied this year.

Technical comments

The mean of exploitable biomass from two surveys is used. There seems to be some confusion over whether these were normalised in the past, but it is stated that they have not been here. This follows the recommendation from WKSKATE. The comment discussing this is left in the advice sheet for clarity to the ADG.
Suggestions were made in the advice sheet using track changes.

Conclusions
The assessment has been performed correctly, following ICES guidance for assessing data limited stocks. Minor comments were made in the advice sheet. Numbers are correct, but have now been rounded.

Rjn.27.3a4

Review of ICES Scientific Report, (*WGEF/ Working Group on Elasmobranch Fishes*) (*2021*) (*15-24 June*)
Reviewer: Cristina Rodríguez-C abello
Expert group Chair: Jurgen Batsleer and Pascal Lorance
Secretariat representative: Inigo Martinez and Jette Fredslund

General

The first figure only shows landings although discards are available. A general discussion arised looking at discards table. As it happens with other elasmobranchs stocks there are gaps among countries and years and overall a very high interannual variation. These precludes the use of discards as are not considered total reliable.

A discussion arised regarding the index used for the stock indicator. Two options were presented, using the exploitable biomass (> 50 cm) or total biomass. Some comments were also made regarding the possibility of changing the explotable biomass length (40 cm instead of 50 cm). WKSKATES had not a clear answer to that point. Some of the arguments discussed were to have an index comparable to fishery but others suggest to look at the length frequency of the survey and take into account other surveys for choosing a standard length as exploitable biomass.

Other important general issue that came about was regarding how to procced for obtaining confidence intervals when more than a survey index is combined.

For single stock summary sheet advice:

1. Assessment type: Update
2. Assessment: Survey-based trends
3. Forecast: Not presented
4. Assessment model: Surveys stock indicator (2 years vs 5 years rule)
5. Data issues: Two surveys were usually used to provide advice NS IBTS-Q1 and NS IBTS-Q3. However the netherlans survey index is also available There are discards data available but are highly variable and thus considered not reliable to include.
6. Consistency: Consistent
7. Stock status: Unknown. The stock size biomass indicator showed a decresing trend
8. Management Plan: No management plan

General comments
The assessment is similar to other elasmobranch stocks showed in the WG. The surveys index and data used were presented and discussed.

Technical comments
Landings in 2009 are very low (Figure 1). This is due to the fact that there was a larger time series of landings however until 2009 it started to be species-specific.
Advice sheet:

- *Landings were review and updated on tables 4 and 6*
- *Legend and symbols on table 6 were modified to be consistent with tables from other stocks."ICES estimates of landings by country (in tonnes). Blank = no data reported; + = data less than 0.5 t."*
- *Table 7. Instead of including each survey index (Q1 and Q3) the standardized average of both index (the stock size indicator) was included.*

Conclusions
The assessment has been performed correctly and all requested information is provided in the advice sheet
Checklist for audit process
General aspects

- Has the EG answered those TORs relevant to providing advice? Yes
- Is the assessment according to the stock annex description? Yes
- If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary? There is not a management plan.
- Have the data been used as specified in the stock annex? Yes
- Has the assessment, recruitment and forecast model been applied as specified in the stock annex?
- Is there any **major** reason to deviate from the standard procedure for this stock? No
- Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice? Yes. The advised landings have been reduced (-36%) because the biomass indicator has decreased and both the uncertainty cap and precautionary buffer were applied

Sho.27.67

Review of ICES Scientific Report, (*WGEF/Working Group on Elasmobranch Fishes*) (*2021*) (15-24 June)
Reviewers: Thomas Barreau
Expert group Chair: Jurgen Batsleer & Pascal Lorance
Secretariat representative: Iñigo Martinez

General
Recommendations, general remarks for expert groups, etc. (use bullet points and subheadings if needed)

Last catch advice for this stock was request in 2017 as it was not requested in 2019. The lack of reference point did not allow to assess the stock relatively to maximum sustainable yield (MSY). The advice is only based on one survey the Spanish SpPGFS-WIBTS-Q4 survey (G5768) using a biomass indicator in kg hr^{-1}.
After discussion during the meeting, landings data have not been used as some data seems not accurate especially in 2006 and landings are not reported at the species level, consequently landings are considered unreliable. Discard data were not considered as reliable either.
There is no TAC for this species.
No Stock Annex is available for this stock.

For single-stock summary sheet advice
Blackmouth dogfish (*Galeus melastomus*) in subareas 6 and 7 (West of Scotland, southern Celtic Seas, and English Channel)

Short description of the assessment as follows (examples in grey text):

1. Assessment type: Cat 3
2. Assessment: Accepted
3. Forecast: Not presented but PA buffer applied on catch scenarios table
4. Assessment model: Category-3 stock assessment based on biomass indicator calculated on one survey (SpPGFS-WIBTS-Q4 survey (G5768)) rules of the 2 years vs 5 years was used. No landings and no discards used.
5. Consistency: following the advice rule for cat 3 with not deviation from the advice rule.
6. Stock status: Unknown. Lack of a reference point. No Stock Status table used this year in the advice.
7. Management plan: There is no management plan available.

General comments

The precautionary buffer was last apply in 2017. Because there is no information on stock size or fishing pressure, it has been apply in 2021. As no reliable data on current catch are available and no catch advice have been given, advice change have been set as "NA".

Technical comments

- Landings plot must be removed in section "Stock development over time" as data are unreliable.
- Ordinate label of the plot "Stock Size" must be changed in kg/hr in section "Stock development over time".
- As only one survey was used, the working group decided to not normalized the index.
- Indicated that last precautionary approach was applied in 2017 in section "Catch Scenario".
- Add a comment on "% Advice change ***" such as "No catch advice given since 2017" or "Because landings or catches are not known, ICES cannot provide advice on fishing opportunities but provides an indication of the relative change in catch implied." in Table 1.
- Replace tables in section "History of the catch and landings" by a sentence such as "All catches data are believed to be un reliable".
- ICES rounding must be applied to the table 8.

Conclusions

The assessment has been performed correctly and all requested information is provided in the advice sheet.

Sho.27.89a

Review of ICES Scientific Report, *(WGEF/Working Group on Elasmobranch Fishes) (2021) (15-24 June)*
Reviewers: Joana Silva
Expert group Chair: Jurgen Batsleer & Pascal Lorance
Secretariat representative: Iñigo Martinez

General

- This species is typically discarded or retained as low-value bycatch.

- Landings data are not fully reliable for this species, as some may be reported in generic categories (e.g. 'dogfish') and, misidentification issues are also likely to occur, especially in Division 9.a where the congener *Galeus atlanticus* also occurs.
- Discards are not fully quantified, and their discard survivability is currently unknown.

For single-stock summary sheet advice

sho.27.89a - Black-mouthed dogfish (*Galeus melastomus*) in Subarea 8 and Division 9.a (Bay of Biscay and Atlantic Iberian waters)

Short description of the assessment as follows:

1. Assessment type: Update (Category-3 stock).
2. Assessment: Accepted.
3. Forecast: Not applicable.
4. Assessment model: Survey-based trends based on four trawl surveys EVHOE–WIBTS–Q4, PT–CTS(UWTV(FU 28–29)), SpGFS-GC-WIBTS-Q1, and SpGFS-GC-WIBTS-Q4.
5. Consistency: Consistent with previous advice.
6. Stock status: Unknown (reference points are not defined due to lack of information).
7. Management plan: ICES is not aware of any agreed precautionary management plan for this stock.

General comments

- ICES has not been requested to provide advice on fishing opportunities for this stock.
- There is a stock annex available with minor review to be followed up intersessionally.

Technical comments

- PT–CTS(UWTV(FU 28–29)) survey was not conducted in 2019 and 2020 (the latter due to COVID-19 restrictions) with stock size indicator for those years as the mean of the remaining surveys. During WGEF meeting options with and without this survey were presented (Moura *et al.*, 2021 WD[2]) and, with little impact shown in the stock size indicator, an agreement was reached to continue to include this survey. However, a second SAG template was made available without this survey to the ADGEF. Raw data available on WGEF 2019 sharepoint.
- The survey code for PT–CTS(UWTV(FU 28–29)) as D2913 was highlighted throughout the advice sheet by the stock assessor to be incorrect since this is not a dredge survey, it would need to be corrected on the database by ICES.
- EVHOE–WIBTS–Q4 survey index was updated in 2021 for the whole time-series following methodology presented during WKSKATE. Previous advice was based on national data, with advice in 2021 based on data available on DATRAS.
- SpGFS-GC-WIBTS-Q1 and SpGFS-GC-WIBTS-Q4 were averaged before normalized by their long-term mean. Data to be uploaded accordingly by stock assessor to the sharepoint.
- Issue found on the stock size indicator for 2012 and 2017, table on advice sheet corrected, with SAG files and stock size indicator graph to be updated on the advice sheet, and report section also to be updated. Stock assessor has been informed and will revise accordingly prior to the ADGEF.

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[2] Moura, T., Rodríguez- Cabello, C., Díez, G., Serra-Pereira, B., Maia, C., Figueiredo, I. 2021. Effect of the Portuguese surveys in the assessment of catsharks syc.27.8c9a and sho.27.89a. Working Document (WD 05) presented to ICES WGEF 15-24 June 2021; 8 pp.

Conclusions
The assessment was carried out according ICES guidelines for data-limited stocks. Minor corrections were made to the advice sheet during the audit, including update of values according to ICES rounding rules. Other updates will be carried out by stock assessor prior to the ADGEF.

Syc.27.8abd

Review of ICES Scientific Report, (*WGEF/Working Group on Elasmobranch Fishes*) (*2021*) (15-24 June)
Reviewers: Pascal Lorance
Expert group Chair: Jurgen Batsleer & Pascal Lorance
Secretariat representative: Iñigo Martinez

General
- The last advice for this stock was published in 2019. Both in 2019 and 2021 CES was not requested to provide advice on fishing opportunities whilst a catch advice was provided in 2017.
- There is no stock annex for this stock.
- The assessment was based on the same survey (EVHOE–WIBTS–Q4) as the three previous assessments published in 2015, 2017 and 2019. Following WKSKATE, data from DATRAS where used in 2021 instead on national data previously and this makes some change in the biomass index, although the overall stock trajectory remains the same.
- Landings and discards have been used since 2017 and are deemed reliable.

For single-stock summary sheet advice

Stock: syc.27.8abd

Short description of the assessment:

1. Assessment type: ICES stock category 3, update
2. Assessment: accepted
3. Forecast: NA
4. Assessment model: None (survey trend only)
5. Consistency: consistent with previous assessment, survey data now using DATRAS induced minor changes.
6. Stock status: NA
7. Management plan: NA

General comments
Although there is no stock annex, the assessments has been carried out using the same survey data since 2015 and catch data since 2017. Changes are technical (moving from national data to DATRAS, which facilitates transparency). The assessment method may then be considered as stabilized and should be subject to writing a stock annex after the use to survey data is reviewed by the next WKSKATE workshop, recommended by WGEF.

Technical comments
ADGEF 2019 noted in the minutes "Need to check that the discard data does not include area 9a". Discards included in the 2021 draft advice are actually for 8abd. In the recommended that

table in the report as amended so to provide time-series of discards by stocks not just by species as currently done (tables 25.2a and 25.2b in WGEF report).

Conclusions
The assessment has been carried out consistently for several years. Catch and survey data are reliable. A stock annex is needed before the next assessment (2023).

Syc.27.8c9a

Review of ICES Scientific Report, (*expert group/workshop title*) (*year*) (*dates*)
Reviewers: Pascal Lorance
Expert group Chair: Jurgen Batsleer & Pascal Lorance
Secretariat representative: Iñigo Martinez

General
- The last advice for this stock was published in 2019. Both in 2019 and 2021 CES was not requested to provide advice on fishing opportunities whilst a catch advice was provided in 2017.
- There is no stock annex for this stock.
- Landings have been used since 2017 and are deemed reliable.

For single-stock summary sheet advice
Stock: syc.27.8c9a

Short description of the assessment:

1. Assessment type: ICES stock category 3, update
2. Assessment: accepted
3. Forecast: NA
4. Assessment model: None (survey trend only)
5. Consistency: The advice is based on the same data since 2017(survey trends for 4 surveys and landings).
6. Stock status: NA
7. Management plan: NA

General comments
- The last advice for this stock was published in 2019. Both in 2019 and 2021 CES was not requested to provide advice on fishing opportunities whilst a catch advice was provided in 2017.
- For this stock survey data from national database are used, which lack transparency. This should be changed to using DATRAS, probably some work to plan for the next WKSKATE workshop.
- The index used is fully consistent since 2017 (standardized Biomass indicator). In the previous advice, confidence intervals were shown and are no longer this year, as the calculation applied was not correct.
- Only landings are used not discards. Discards are noted unknown in the draft advice. The report provides some discard data, which are incomplete for one country as "*estimates for the* [Portuguese] *artisanal fleet are not available*". However, discards estimates are of little interest for assessment and advice of the species because survival is unknown and most probably variable according to gear and season

Technical comments
Although there is no stock annex, the assessments has been carried out using the same survey data since 2015 and landings data since 2017 (so assessment method is stabilized and should be subject to writing a stock annex after the use of survey data is reviewed by the next WKSKATE workshop, recommended by WGEF). Work is needed to estimate confidence interval of the combined survey index and to used DATRAS which would allow moving to stock to TAF (this is not specific to this stock and applies to all WGEF stocks). The assessment method may then be considered as.

Conclusions
The assessment has been carried out consistently for several years. Landings and survey data are reliable. A stock annex is needed before the next assessment (2023).

Syc.27.67a-ce-j

Review of ICES Scientific Report, (*WGEF/Working Group on Elasmobranch Fishes*) (*2021*) (15-24 June)
Reviewer: Thomas Barreau
Expert group Chair: Jurgen Batsleer & Pascal Lorance
Secretariat representative: Iñigo Martinez

General
Recommendations, general remarks for expert groups, etc. (use bullet points and subheadings if needed)

Last catch advice for this stock was request in 2019. The lack of reference point did not allow to assess the stock relatively to maximum sustainable yield (MSY).
The advice is based on four surveys EVHOE–WIBTS–Q4 (G9527), IGFS–WIBTS–Q4 (G7212), SpPGFS–WIBTS–Q4 (G5768), UK(E&W)–BTS–Q3 (B6596) using a relative index. Index for UK(E&W)–BTS–Q3 (B6596) in 2020 were not used as this survey did not cover area 7a due to COVID-19 restrictions.
The total biomass has been used in this advice as the smaller individual can be retained for bait.
Landings appear to be relatively stable since 2007, data presented do not include generic selling names.
Discards data were not used as they are not fully quantified and are variable between fleets.
There is no TAC for this species.
No Stock Annex is available for this stock.

For single-stock summary sheet advice

Lesser spotted dogfish (Scyliorhinus canicula) in Subarea 6 and divisions 7.a–c and 7.e–j (West of Scotland, Irish Sea, southern Celtic Seas)

Short description of the assessment as follows (examples in grey text):
1. Assessment type: Cat 3
2. Assessment: Accepted
3. Forecast: Not presented.
4. Assessment model: Category-3 stock assessment based on relative indicator calculated on four surveys (EVHOE–WIBTS–Q4 (G9527), IGFS–WIBTS–Q4 (G7212),

SpPGFS–WIBTS–Q4 (G5768), UK(E&W)–BTS–Q3 (B6596)) rules of the 2 years vs 5 years was used. Landings were presented but not discards.

5. Consistency: following the advice rule for cat 3 with not deviation from the advice rule
6. Stock status: Unknown. Lack of a reference point. No Stock Status table used this year in the advice.
7. Management plan: There is no management plan available.

General comments

The precautionary buffer was last applied in 2019 and its application was therefore not considered this year.

Discards are supposed to be similar at landings data but are not fully quantify

Technical comments

- Fisheries-independent trawl survey indices were updated and combined after been normalised. The stock size indicator is based on four surveys, which cover most of the stock area.
- It should be mention in figure 1 legend that data are based on Total biomass in section "Stock development over time".
- Surveys' codes are missing in figure 1 legend in section "Stock development over time".
- Graph on discard must be added in section "Issues relevant for the advice".

Conclusions

The assessment has been performed correctly and all requested information is provided in the advice sheet.

Annex 4: List of Stock Annexes

The table below provides an overview of the WGEF Stock Annexes. Stock annexes for other stocks are available on the ICES website Library under the Publication Type “Stock Annexes”. Use the search facility to find a particular Stock Annex, refining your search in the left-hand column to include the *year*, *ecoregion*, *species*, and *acronym* of the relevant ICES expert group.

Stock id	Stock name	Last updated	Link
dgs.27.nea	Spurdog (*Squalus acanthia*) in subareas 1-10, 12 and 14 (the Northeast Atlantic and adjacent waters)	March 2021	dgs.27.nea_SA
rjb.27.89a	Common skate (*Dipturus batis* - complex) in Subarea 8 and Division 9.a (Bay of Biscay and Atlantic Iberian waters)	April 2014	rjb-89a_SA
rjc.27.8	Thornback ray (*Raja clavata*) inSubarea 8 (Bay of Biscay)	June 2014	rjc-bisc_SA
rjc.27.7e	Thornback ray (*Raja clavata*) in Division 7.e (western English Channel)	June 2014	rjc-echw_SA
rjc.27.9a	Thornback ray (*Raja clavata*) in Division 9.a (Atlantic Iberian waters)	2014	rjc-pore_SA
rje.27.7de	Small-eyed ray (*Raja microocellata*) in divisions 7.d and 7.e (English Channel)	June 2014	rje-ech_SA
rjh.27.9a	Blonde ray (*Raja brachyura*) in Division 9.a (Atlantic Iberian waters)	2014	rjh-pore_SA
rjm.27.8	Spotted ray (*Raja montagui*) in Subarea 8 (Bay of Biscay)	June 2020	rjm.27.8_SA
rjm.27.9a	Spotted ray (*Raja montagui*) in Division 9.a (Atlantic Iberian waters)	2014	rjm-pore_SA
rjn.27.678abd	Cuckoo ray (*Leucoraja naevus*) in Division 678abd (West of Scotland, southern Celtic Seas, western English Channel and Bay of Biscay)	August 2020	rjn.27.678abd
rjn.27.8c	Cuckoo ray (*Leucoraja naevus*) in Division 8.c (Cantabrian Sea)	August 2020	rjn.27.8c_SA
rjn.27.9a	Cuckoo ray (*Leucoraja naevus*) in Division 9.a (Atlantic Iberian waters)	2020	rjn.27.27.9a_SA
rju.27.9a	Undulate ray (*Raja undulata*) in Division 9.a (Atlantic Iberian waters)	2014	rju-9a_SA
rju.27.7de	Undulate ray (*Raja undulata*) in divisions 7.d and 7.e (English Channel)	2020	rju.27.7de_SA
sck.27.nea	Kitefin shark (*Dalatias licha*) in subareas 1-10, 12 and 14 (the Northeast Atlantic and adjacent waters)	2015	sck-nea_SA

Stock id	Stock name	Last updated	Link
bsk.27.nea	Basking shark (*Cetorhinus maximus*) in Sub-areas 1-10, 12 and 14 (the Northeast Atlantic and adjacent waters)	June 2015	bsk-nea_SA
cyo.27.nea	Portuguese dogfish (*Centroscymnus coelolepis*, *Centrophorus squamosus*) in subareas 1-10, 12 and 14 (the Northeast Atlantic and adjacent waters)	February 2010	cyo-nea_SA
guq-nea	Stock Annex: Leafscale gulper shark (*Centrophorus squamosus*) in subareas 1-10, 12 and 14 (the Northeast Atlantic and adjacent waters)	February 2010	guq-nea_SA
por-nea	Porbeagle (*Lamna nasus*) in subareas 1-10, 12 and 14 (the Northeast Atlantic and adjacent waters)	June 2010	por.27.nea_SA
sho.27.89a	Black-mouth dogfish (*Galeus melastomus*) in Subarea 8 and Division 9.a (Bay of Biscay and Atlantic Iberian waters)	June 2019	sho.27.89a_SA
syc.27.8abd	Lesser-spotted dogfish (*Scyliorhinus canicula*) in divisions 8.a-b and 8.d (Bay of Biscay)	June 2019	syc.27.8abd_SA
syc.27.8c9a	Lesser-spotted dogfish (*Scyliorhinus canicula*) in divisions 8.c and 9.a (Cantabrian Sea and Atlantic Iberian waters)	July 2021	syc.27.8c9a_SA
syt.27.67	Greater-spotted dogfish (*Scyliorhinus stellaris*) in subareas 6 and 7 (West of Scotland, southern Celtic Sea, and the English Channel)	June 2019	syt.27.67_SA
Other deep-water sharks	Other deep-water sharks and skates from the Northeast Atlantic (ICES Subareas 4–14)	June 2019	Other deep-water sharks_SA

Annex 5: List of Working Documents 2021

WD number	Title	Authors
01	Abundance, biomass and CPUE of deep-water sharks in the longline survey (PALPROF) in the Bay of Biscay (ICES 8c) from 2015 to 2020.	Diez *et al*.
02	Population structure of the porbeagle shark in the Bay of Biscay inferred using molecular markers	Viricel *et al*.
03	Results on main elasmobranch species from 2001 to 2020 Porcupine Bank (NE Atlantic) bottom trawl surveys	Fernandez-Zapico *et al*.
04	Results on main elasmobranch species captured in the bottom trawl surveys on the Northern Spanish Shelf	Fernandez-Zapico *et al*.
05	Effect of the Portuguese surveys in the assessment of catsharks syc.27.8c9a and sho.27.89a	Moura *et al*.
06	Overview of data relating to Dipturus species	Ellis and Silva
07	Assessment of historical trends in NEA porbeagle stock biomass using SPiCT	Biais
08	Summary of the information available for Dipturus spp. from Portuguese mainland waters	Serra-Pereira *et al*.
09	Testing LBI parameters on *Scyliorhinus canicula* (syc.27.8c9a) Iberian stock	Rodrigues-Cabello *et al*.
10	Catsharks and smooth-hounds in the UK (E&W) beam trawl survey of the Irish Sea (ICES Division 7.a) and Bristol Channel (ICES Division 7.f–g)	Silva and Ellis
12	Knowledge available on common skate from the French National Museum of Natural History and from European research surveys	Barreau and Iglésias
13	EMFF-project “Raywatch” (2020-2022)	Lemey *et al*.
11	Discards of elasmobranch species by the Portuguese bottom otter trawl fisheries in ICES Division 27.9.a	Fernandes